ENGINEERING

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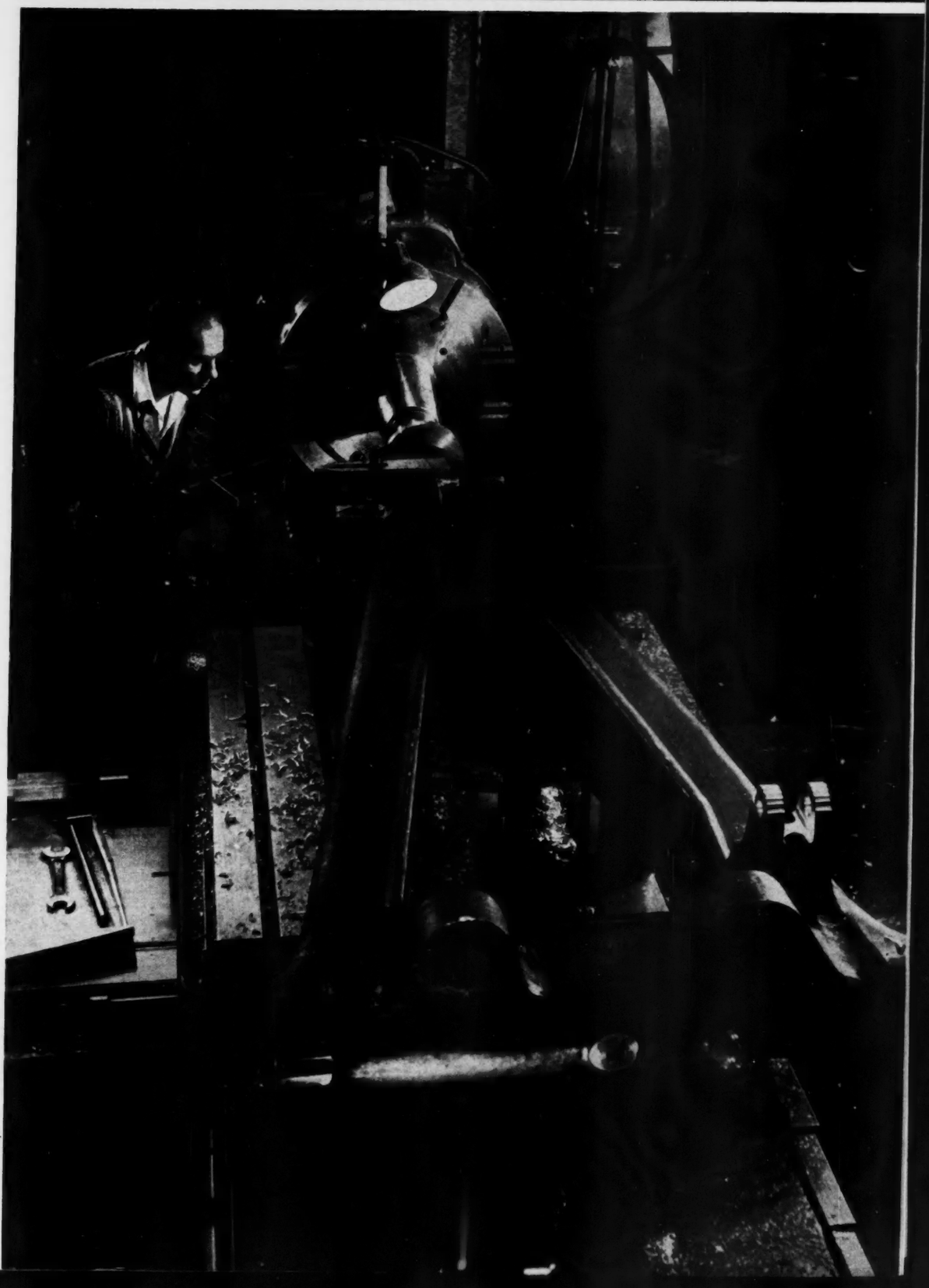

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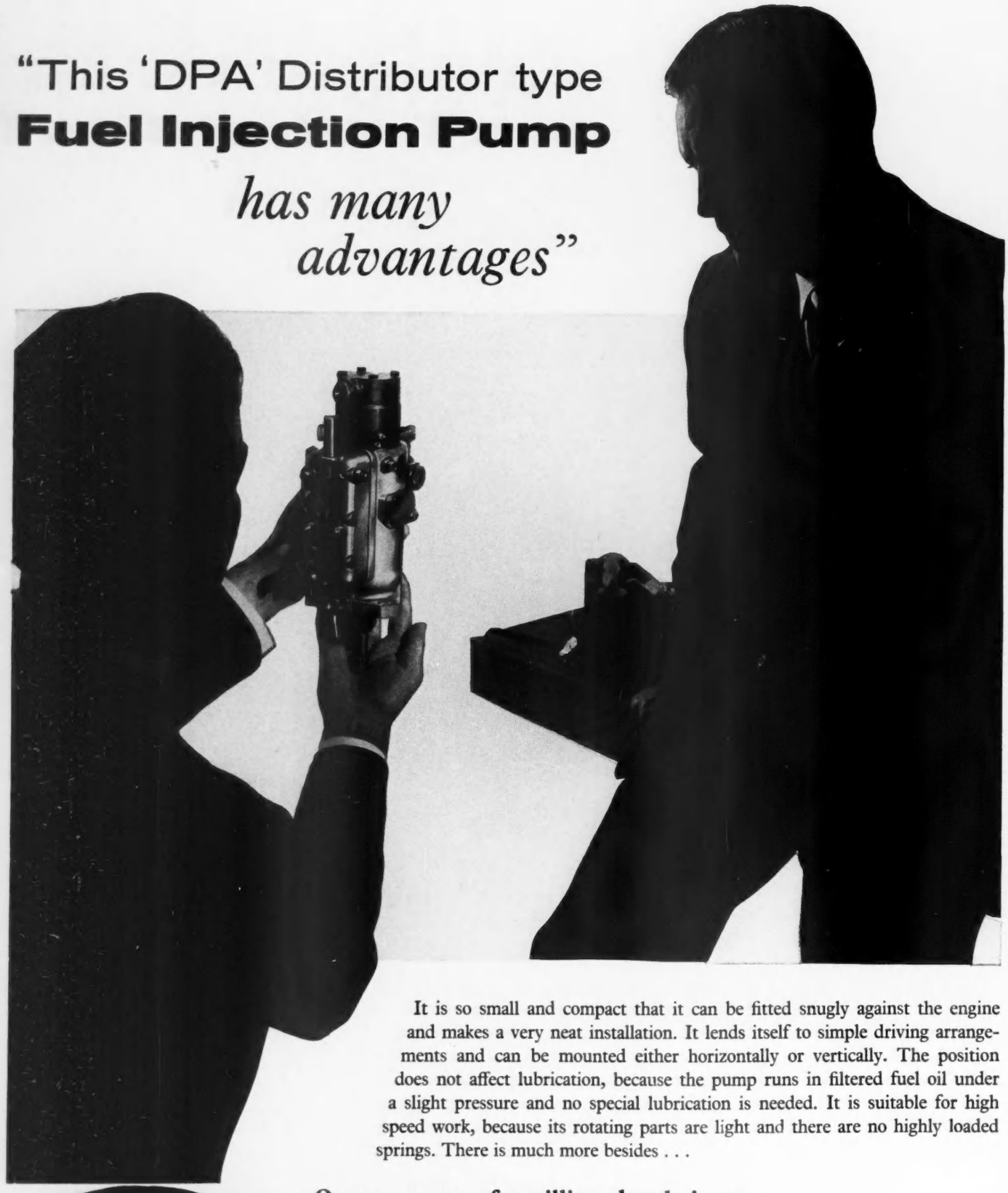

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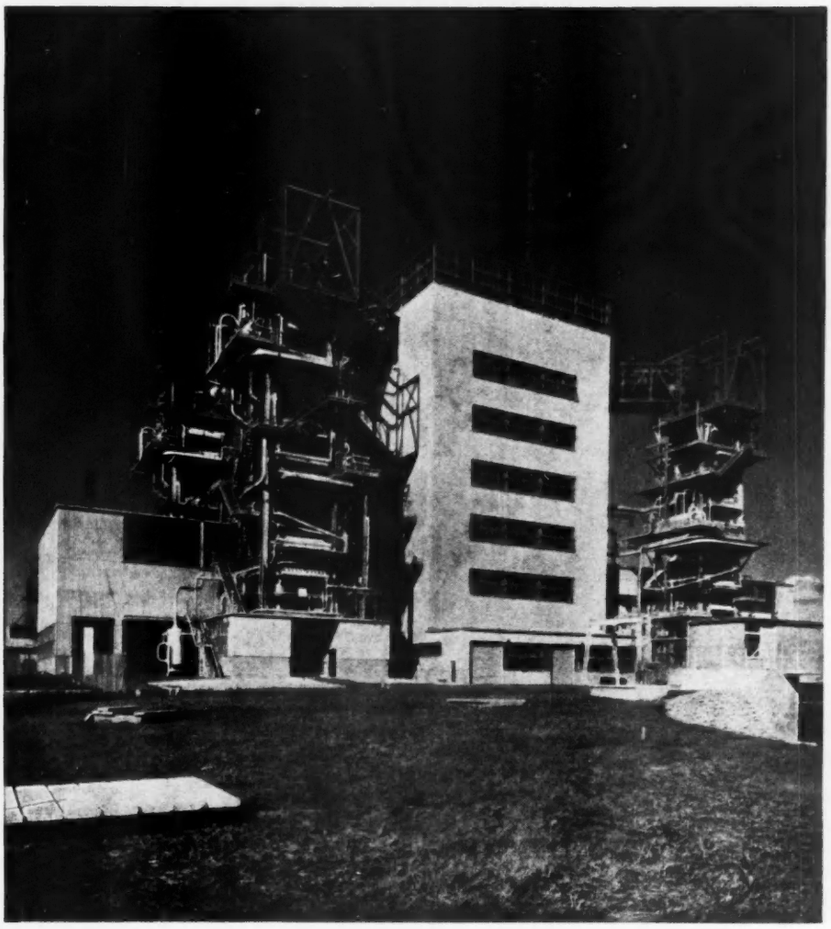

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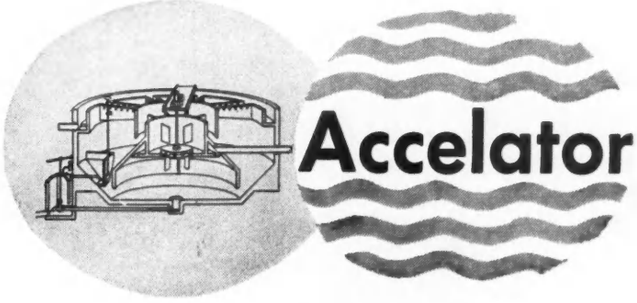

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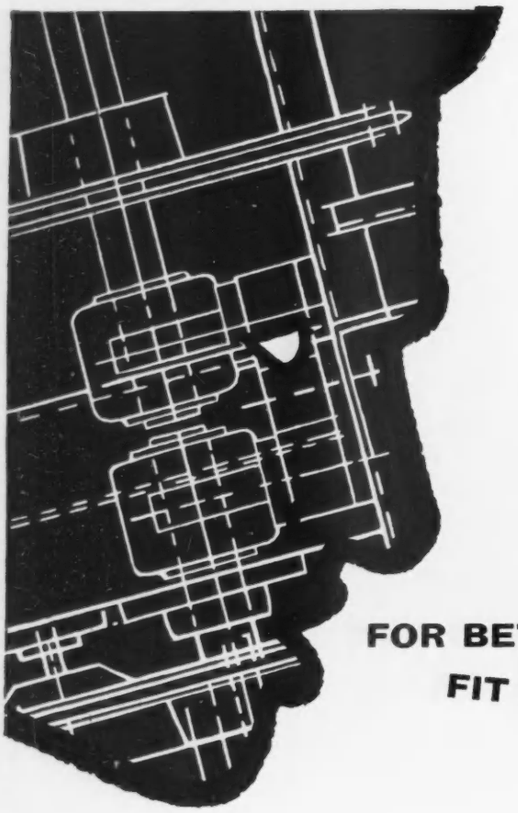

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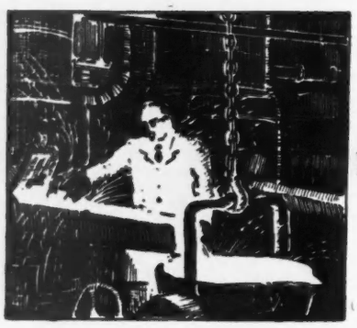

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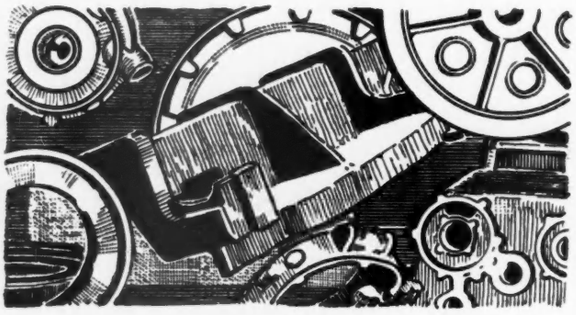

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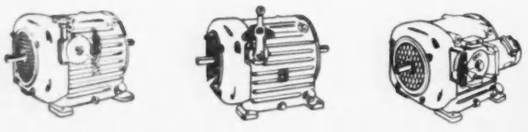

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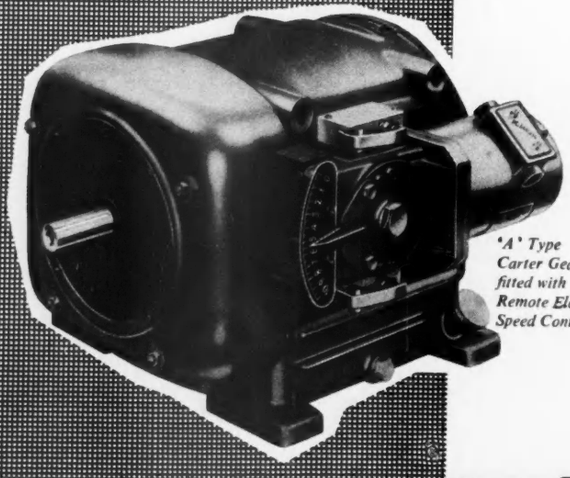

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Facing the head of one of the largest undercarriage electronc alloy castings produced in the country. Because of its size and the small production batches involved, the major part of the work is produced freehand. (*Nurnberg photograph for* ENGINEERING.)

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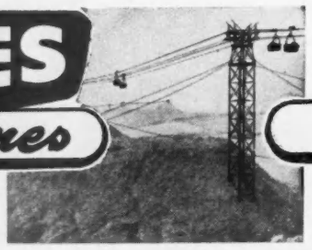

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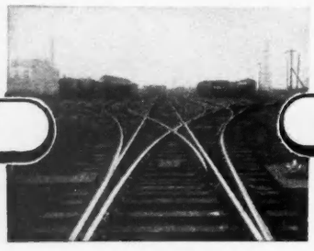

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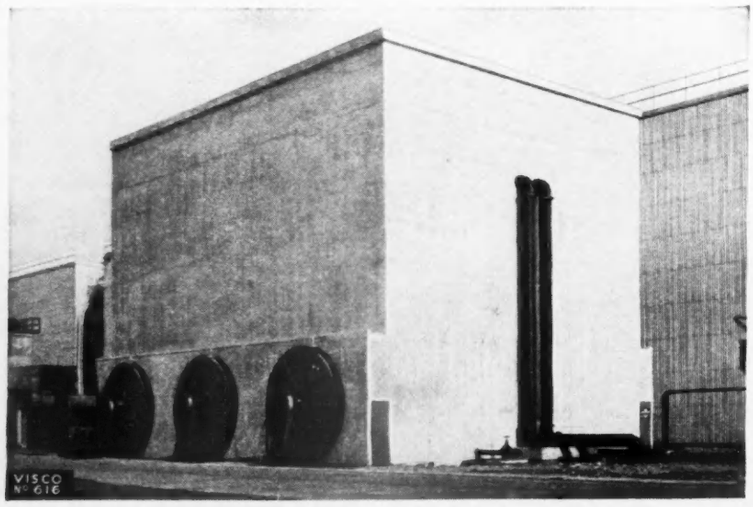

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PUBLIC NOTICE

ADMINISTRATIVE COUNTY OF LONDON
LONDON BUILDING ACT (AMENDMENT) ACT, 1935
LONDON BUILDING (CONSTRUCTIONAL) BY-LAWS, 1952
CLEAN AIR ACT, 1956

The London County Council gives notice in accordance with Section 8(*b*) of the London Building Act (Amendment) Act, 1935, that on 26th January, 1960, it made the London Building (Constructional) Amending By-law, 1960, under the above-mentioned Acts amending the London Building (Constructional) By-laws, 1952, by the addition thereto of a by-law requiring the provision in new buildings of such arrangements for heating and cooking as are calculated to prevent, so far as is practicable, the emission of smoke.

The Council has fixed 1st April, 1960, as the date on which the by-law shall come into operation.

A copy of the by-law is deposited at the County Hall, Westminster Bridge, S.E.1, and can be inspected at all reasonable hours.

Copies can be obtained from the Information Bureau at the County Hall on request. Requests by post should be accompanied by a stamped addressed envelope.

W. O. HART,
CLERK OF THE COUNCIL (577).

THE COUNTY HALL, S.E.1.
21st MARCH, 1960. B 614

EDUCATIONAL

BLACKPOOL TECHNICAL COLLEGE AND SCHOOL OF ART

A Short Course in RUSSIAN for scientists, technicians and those engaged in industry, will be held from 16th to 21st May, 1960 (full-time) at Blackpool Technical College and School of Art. Details may be obtained from the PRINCIPAL OF THE COLLEGE, PALATINE ROAD, BLACKPOOL, LANCASHIRE. B 635

UNIVERSITY OF CAMBRIDGE DEPARTMENT OF ENGINEERING

POST-GRADUATE COURSE IN STRUCTURES AND MATERIALS

The 1960-61 Post-Graduate Course in THEORY OF STRUCTURES AND STRENGTH OF MATERIALS will be held in the Department of Engineering, Cambridge University, beginning on 5th October, 1960, and finishing in June, 1961.

The latest advances made in the understanding of the behaviour of metallic structures under static, repeated or fatigue loading will be the principal subject of the course, with particular emphasis on welding as a method of fabrication. No attempt will be made to teach conventional methods of design, but present-day practice and possible future developments will form the subject of critical study.

The object of the course is not to train research workers, but to help engineers to apply the latest advances in knowledge. The course will include lectures, colloquia and laboratory work, and each student will be encouraged to make a detailed study of some problem of particular interest to him.

The course is open to university graduates with industrial experience, and to others with suitable equivalent qualifications and of sufficient experience to obtain full benefit from a post-graduate course.

Further details and forms of application for admission may be obtained from the SECRETARY, CAMBRIDGE UNIVERSITY ENGINEERING LABORATORY, TRUMPINGTON STREET, CAMBRIDGE. The completed forms of application should be returned to the Secretary not later than 31st May, 1960. B 633

THE COLLEGE OF AERONAUTICS
ONE YEAR POST-GRADUATE COURSE IN FLIGHT CONTROL
1960-1961

Applications are invited for the one year course in FLIGHT CONTROL which begins on 10th October, 1960. Prospective students must be of graduate status in an appropriate branch of science or engineering, or have attended a preliminary one year course at the College and, preferably, have had practical experience.

The purpose of the course is to give instruction in the techniques employed in the automatic control of all types of flying machine.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from the WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. B 624

THE COLLEGE OF AERONAUTICS
ONE YEAR POST-GRADUATE COURSE IN CONTROL ENGINEERING
1960-1961

Applications are invited for the one year course in CONTROL ENGINEERING which begins on 10th October, 1960. Prospective students must be of graduate status in an appropriate branch of science or engineering, or have attended a preliminary one year course at the College, and preferably, have had practical experience.

The purpose of the course is to give instruction in the techniques employed in control engineering as applied in a wide range of industries.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from the WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. B 623

THE INSTITUTION OF CHEMICAL ENGINEERS
36TH (1960) EXAMINATION

Application forms for entrance to the **1960 EXAMINATION,** returnable not later than the 1st June, 1960 (1st July for those taking Part 3 (The Design Problem) only), may be obtained from The GENERAL SECRETARY, THE INSTITUTION OF CHEMICAL ENGINEERS, 16, BELGRAVE SQUARE, LONDON, S.W.1. B 619

UNIVERSITY OF CAMBRIDGE
DEPARTMENT OF ENGINEERING
POSTGRADUATE COURSE IN CONTROL ENGINEERING

THE 1960-61 POSTGRADUATE COURSE IN CONTROL ENGINEERING will begin on 5th October, 1960, and will last approximately nine months. This course has been established in order to meet the needs of Industry for men trained to a high standard in the theoretical principles and practical application of automatic control and to afford opportunity for study of advanced techniques and modern development in the general field of Control Engineering.

The number of students will be limited and applications must reach the Secretary of the Department not later than 31st May, 1960. Candidates should hold a degree in Engineering or a suitable alternative qualification and have had some practical training and experience. They may be required to attend for interview in Cambridge.

Further details and forms of application for admission may be obtained from the SECRETARY CAMBRIDGE UNIVERSITY DEPARTMENT OF ENGINEERING, TRUMPINGTON STREET, CAMBRIDGE. B 611

THE COLLEGE OF AERONAUTICS
A COURSE OF LECTURES ON PROBLEMS IN HYPERSONIC AERODYNAMICS

will be given at the College from MONDAY, 2nd MAY TO FRIDAY, 13th MAY, 1960

The course is intended for aerodynamicists, physicists and research workers who require a working knowledge of hypersonic aerodynamics. A knowledge of subsonic and supersonic aerodynamics and of mathematics up to degree level is desirable.

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Residence Charge (including full board)	10 guineas

Forms of enrolment and copies of the syllabus may be obtained from the WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. B 607

CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY
MANRESA ROAD, LONDON, S.W.3
DEPARTMENT OF MATHEMATICS

The next **SANDWICH COURSE IN APPLICABLE MATHEMATICS** (of four years' duration) will begin in September, 1960. The course is recognised for the award of the Diploma in Technology. State Scholarships, Technical State Scholarships, and Local Education Authority awards may be held by students attending this course.

Enquiries are invited from students and also from industrial organisations, schools and further education establishments which may wish to recommend students for the course.

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TENDERS

ELECTRICITY CORPORATION OF NIGERIA

INVITATION TO TENDER
HIGH VOLTAGE SWITCHBOARD

The Electricity Corporation of Nigeria invites

TENDERS for the Supply c.i.f. Port-Harcourt of:

1 NO. 8 PANEL SWITCHBOARD

fitted with 5 Solenoid operated oil circuit breakers insulated for 11 kV having a minimum fault rating of 250 MVA at 6600 Volts.

Tender documents giving further details of the Contract may be obtained from THE RESIDENT ENGINEER, ELECTRICITY CORPORATION OF NIGERIA, ADELPHI, JOHN ADAM STREET, LONDON, W.C.2.

Each Tender must be enclosed in a sealed envelope marked "Confidential—Tender for Supply of High Voltage Switchboard" and must be received at the Office of THE SECRETARY, ELECTRICITY CORPORATION OF NIGERIA, 13, BROAD STREET, PRIVATE MAIL BAG 2030, LAGOS, NIGERIA, WEST AFRICA, not later than noon on Saturday, 23rd April, 1960. Tenders received in any other manner will not be considered.

The electricity Corporation of Nigeria does not undertake to accept the lowest or any Tender.

Further information concerning this Contract may be obtained on application to the Resident Engineer.

C. K. O. ADENAIKE,
ACTING SECRETARY TO THE CORPORATION. B 642

THE OFFICE OF THE KERALA STATE ELECTRICITY BOARD, CIVIL BRANCH, POST BOX No. 21, TRIVANDRUM 1, SOUTH INDIA, invites tenders for the following:—

TENDER ENQUIRY NO. HEP 4/60

"For the supply of Butterfly Valves, By-Pass Valves, Air Valves, etc., for Penstock Lines."

Detailed tender specifications can only be obtained from the Office of the Additional Chief Engineer (Construction), Kerala State Electricity Board, Civil Branch, Post Box No. 21, Trivandrum 1, South India, on payment of £2 1s. 6d. per tender enquiry and 11 shillings for each additional copy.

Earnest money amounting to £225/- shall be furnished along with the tender.

Remittance towards cost of specifications are not refundable.

Tenders are due for return to Kerala State Electricity Board at the above address by 3 p.m. on 18th April, 1960, and NOT to this office.

Specimen copy of the above tender enquiry can be seen at ENGINEERING BRANCH, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, under the following reference S.4242/59/NSC/ENG.2. B 656

METROPOLITAN WATER, SEWERAGE AND DRAINAGE BOARD NEW SOUTH WALES, AUSTRALIA

JOB NO. 3389-W

TENDERS are invited for the manufacture, supply, testing and delivery f.o.b. of approximately **100 MILES OF 4-INCH NOMINAL DIAMETER, CENTRIFUGALLY SPUN, CEMENT LINED OR UNLINED, CAST IRON PIPES** suitable for "push-in" rubber ring joints, with unlined cast iron bends, tees and hydrant tees, suitable for lead jointing.

Copies of the Specification and tender documents may be obtained on application to the Agent-General for New South Wales, 56/57, Strand, London, W.C.2.

Tenders must be delivered to the SECRETARY METROPOLITAN WATER, SEWERAGE AND DRAINAGE BOARD, 341, PITT STREET, SYDNEY, NEW SOUTH WALES, AUSTRALIA, not later than 2 p.m. on Tuesday, 12th April, 1960. B 651

THE OFFICE OF THE INDIA SUPPLY MISSION, 2536, MASSACHUSETTS AVENUE, N.W., WASHINGTON 8 D.C., UNITED STATES OF AMERICA, invites tenders for the following:—

(*a*) **TENDER ENQUIRY NO. SE 57/REIN**

"For the Supply of Heavy Duty Greasing Units required for servicing and lubrication of trucks and construction equipment for Nagarjunasagar Project."

(*b*) **TENDER ENQUIRY NO. SE 150**

"For the supply of Hot Line Tools and Equipment required by Bombay State Electricity Board, Bombay, India."

(*c*) **TENDER ENQUIRY NO. SE 155**

"For the supply of L.T. 660V and 3300V Pliable Armoured Flexible Cables required by Neyveli Lignite Corporation (Private) Limited, Madras, India."

Specifications, etc., relative to the above specification scan be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of 14 shillings and 3 pence per tender enquiry, and is not refundable.

Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8 D.C., United States of America, so as to reach them by (*a*) 19th April, 1960, (*b*) 14th April, 1960, and (*c*) 5th May, 1960.

Specimen copy of the above enquiries can be seen at ENGINEERING BRANCH, INDIA STORE DEPARTMENT, BROMYARD AVENUE, ACTON, W.3, under the following references (*a*) S.4243/59/NSC/ENG.2, (*b*) S.4244/59/NSC/ENG.2 and (*c*) S.4205/59/NSC/ENG.2. B 655

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With reference to the enquiry which appeared in the local Press on 4th September, 1959, calling for tenders for the above project. The Due Date for parts **A** and **B** (i.e., Ammonia Plant and Urea Plant) have been extended from **29TH FEBRUARY, 1960, TO 30TH APRIL, 1960.**

Parts **C** and **D** must still be submitted by **30TH JUNE, 1960.** B 632

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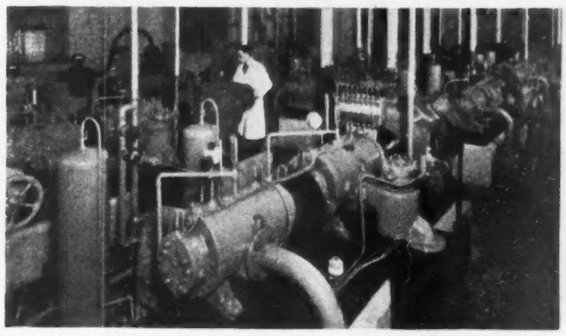

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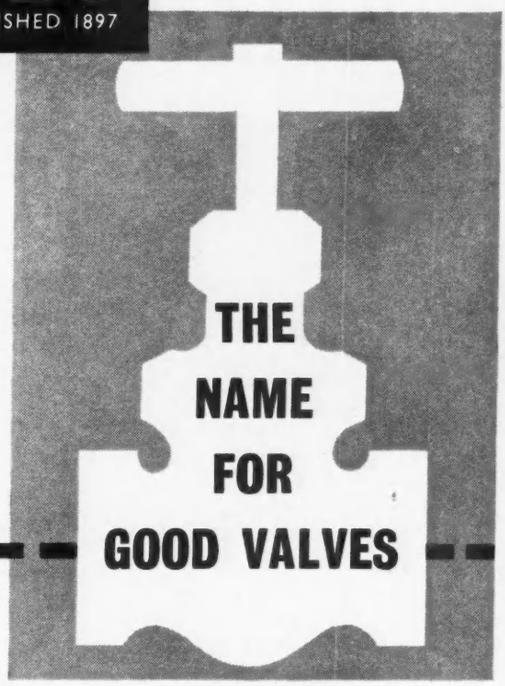

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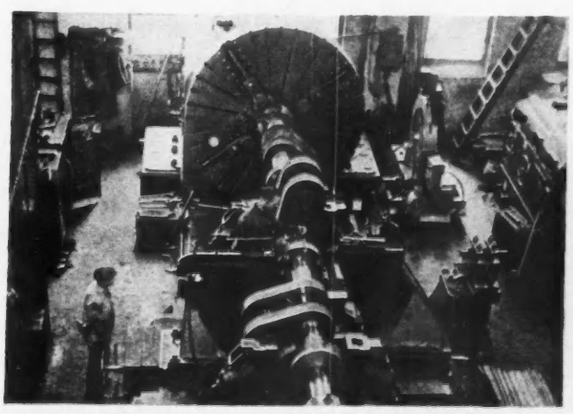

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Typical core mechanical properties of 3 per cent nickel-chromium steel

EN36

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1½ in. dia.	Oil quenched 780°C.	72·0	19	69
2½ in. dia.	Oil quenched 860°C.	62·7	19	67
3 in. dia.	Oil quenched 780°C. Oil quenched 860°C. Oil quenched 780°C.	59·7	22	72

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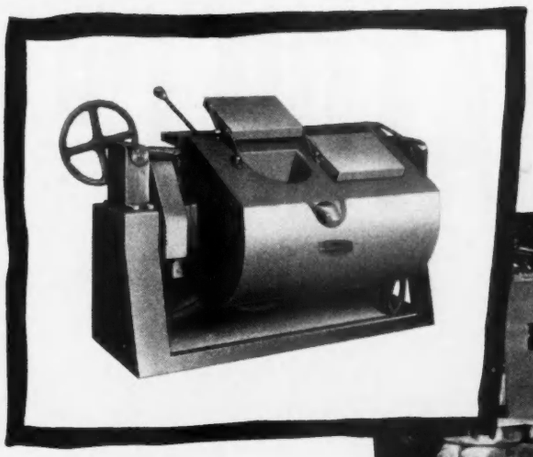
TGA 21/25



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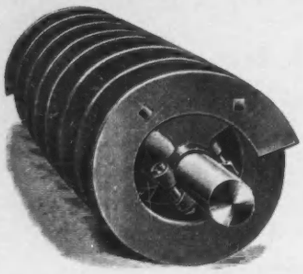

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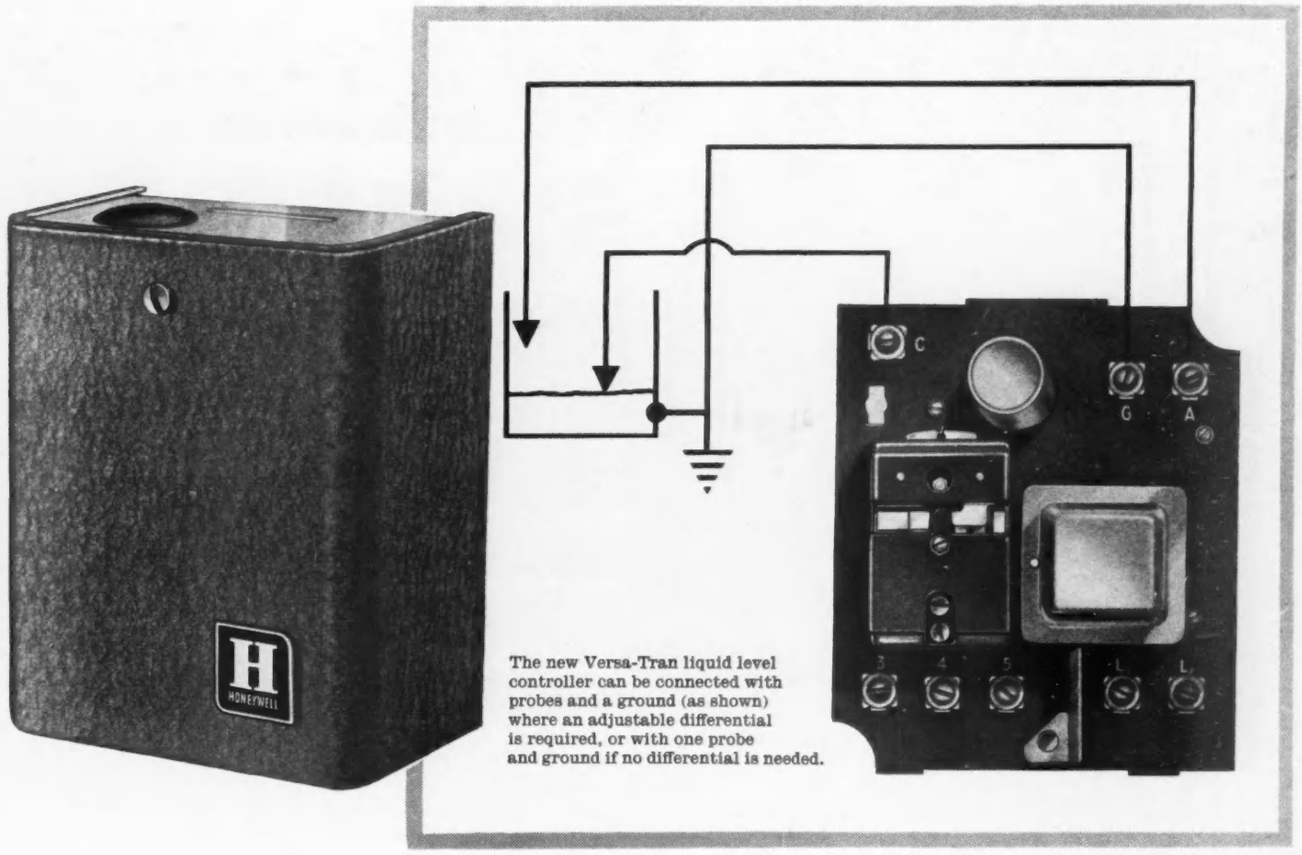

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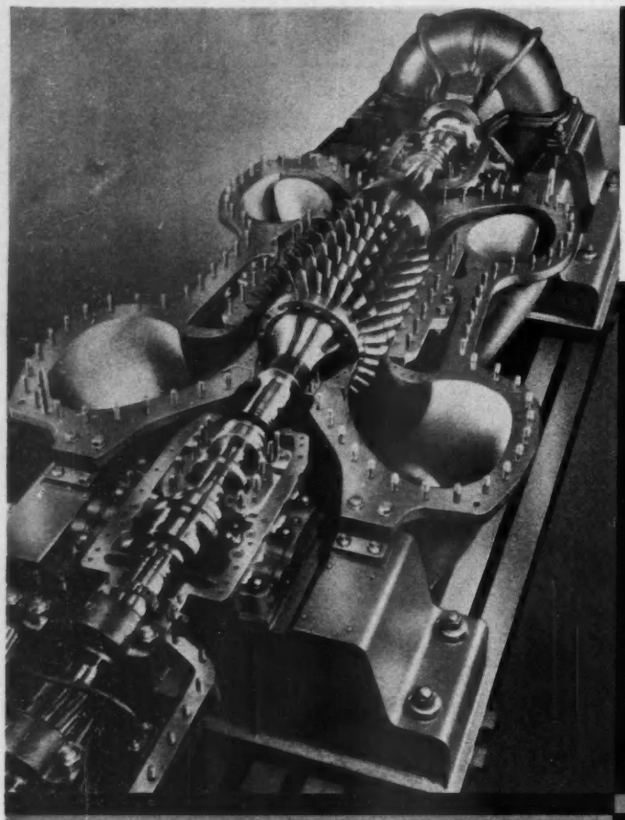

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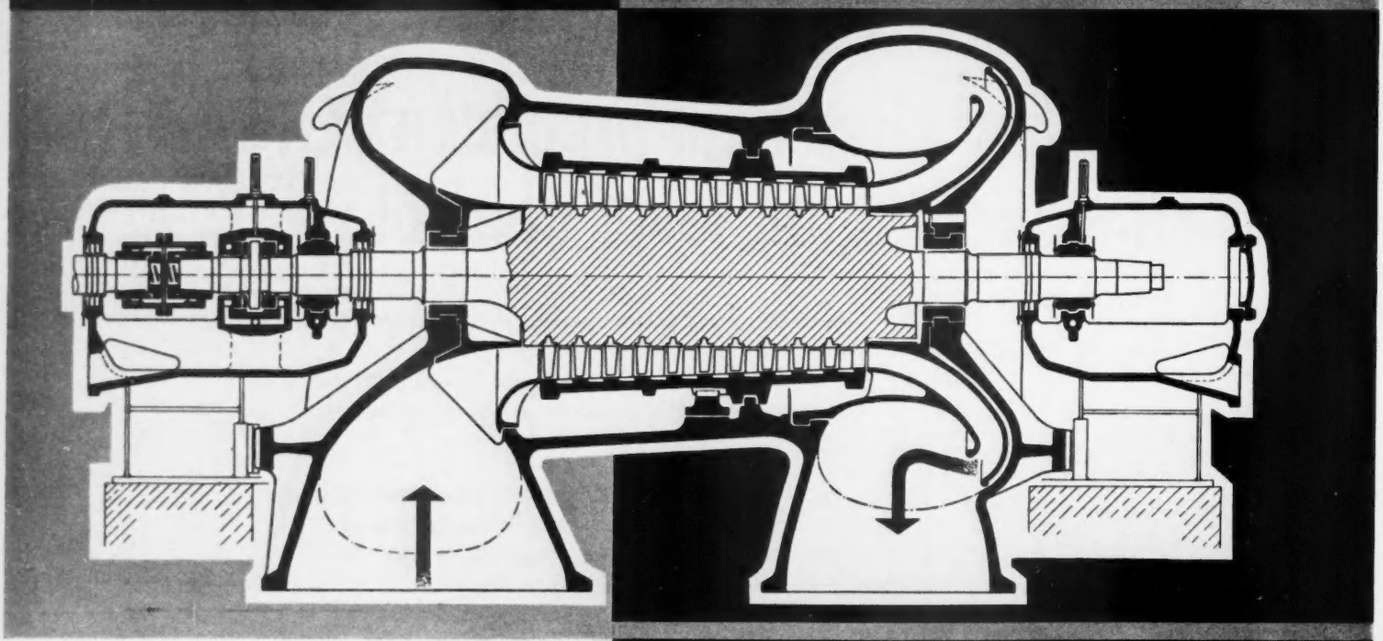

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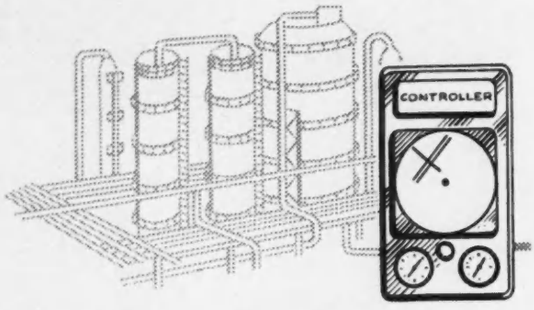

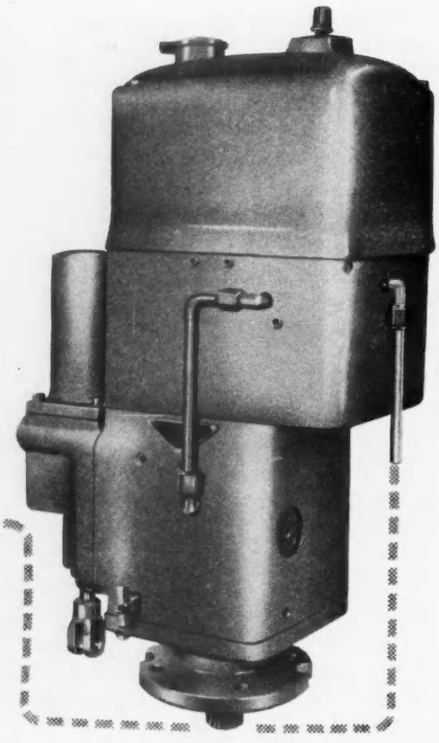

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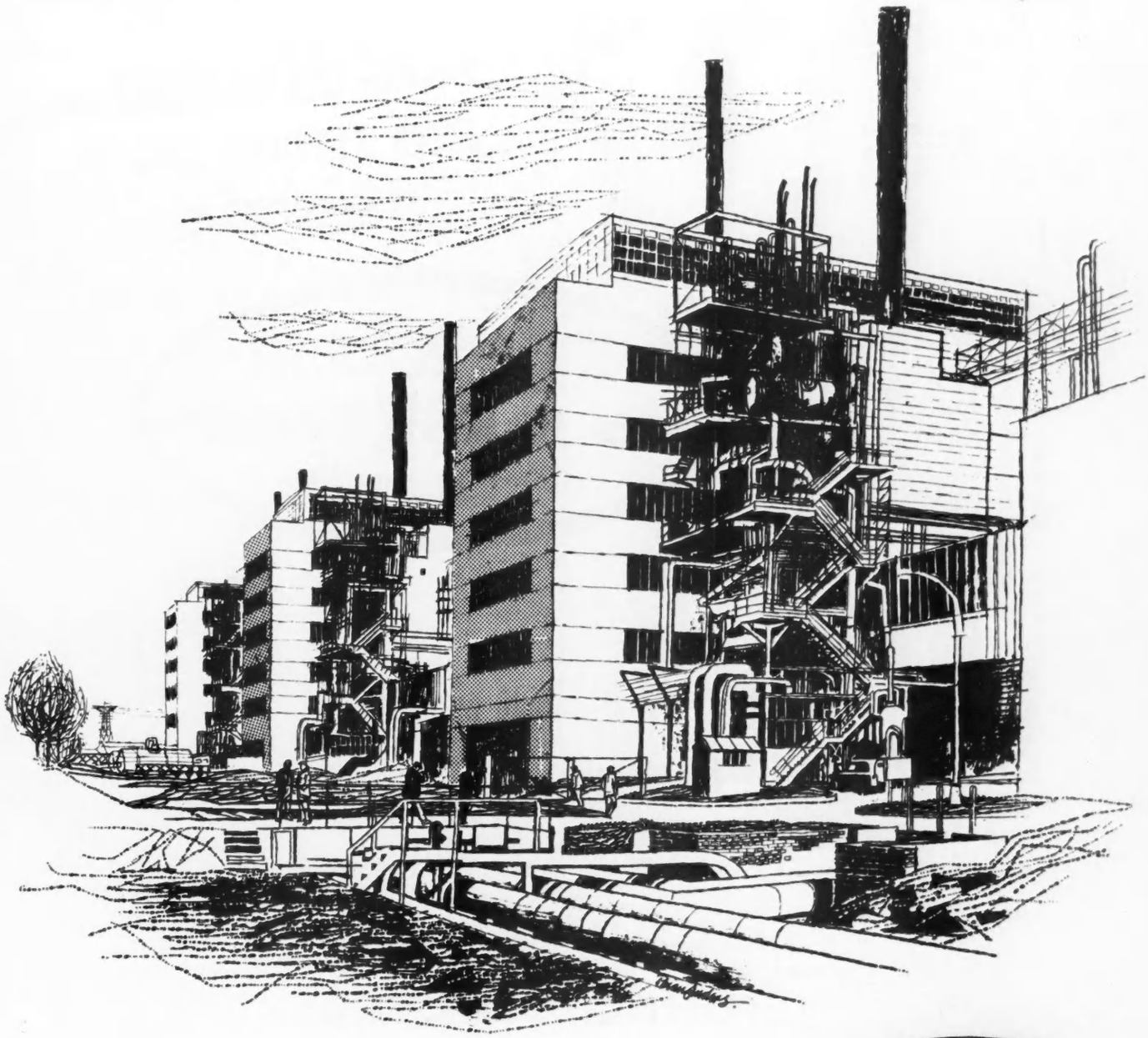

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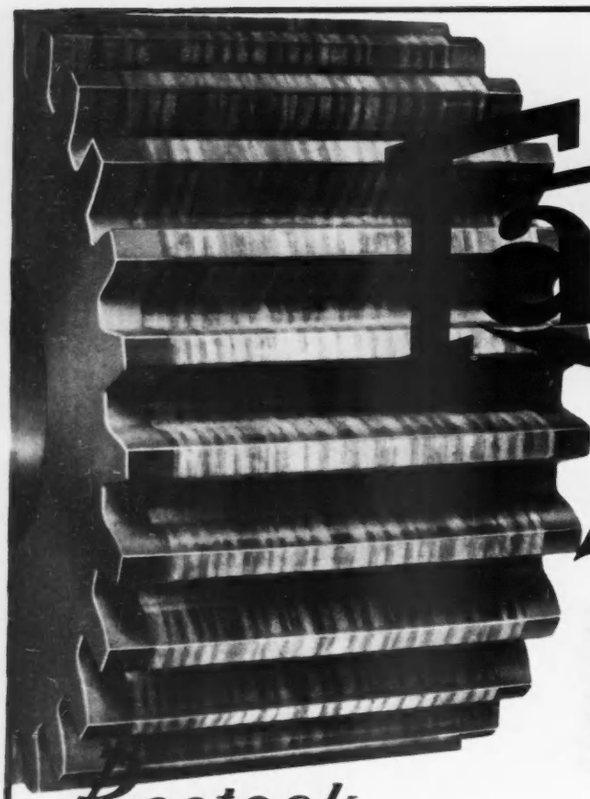

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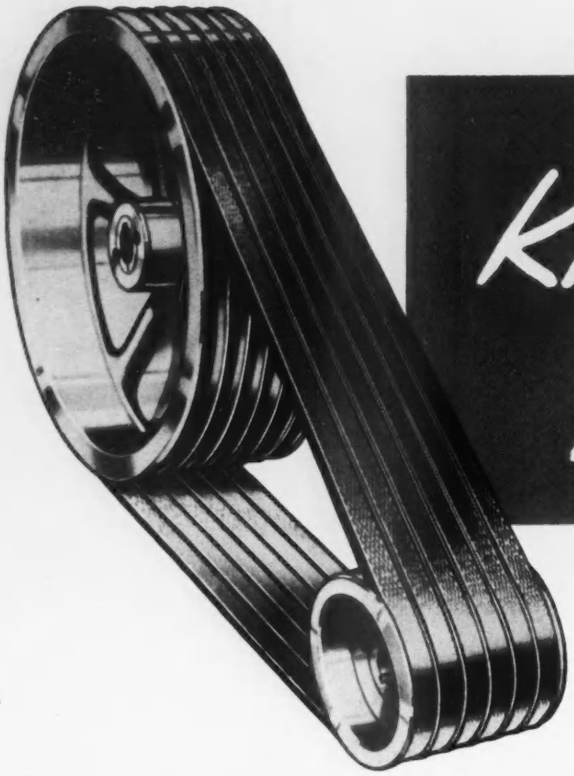

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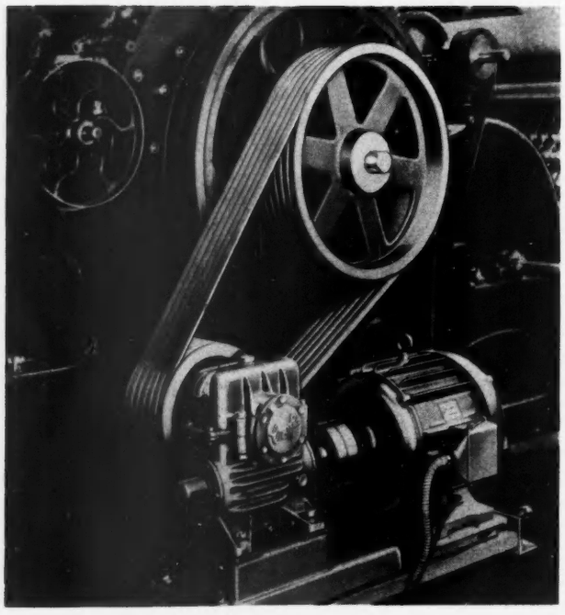

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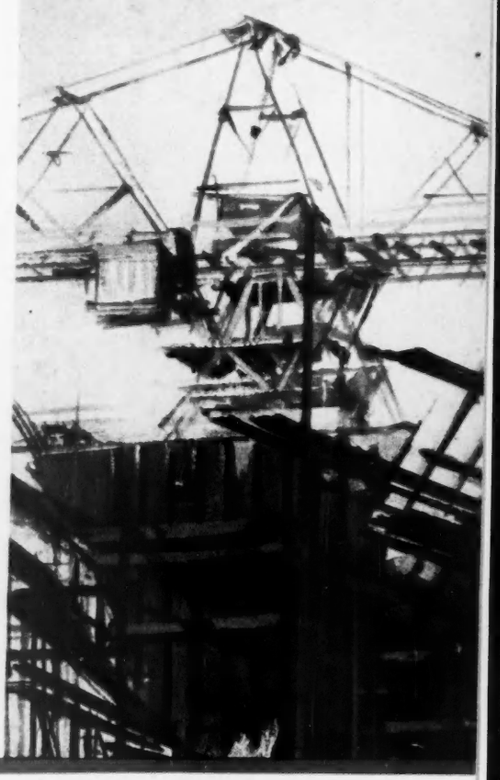

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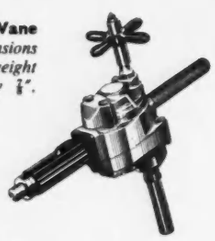

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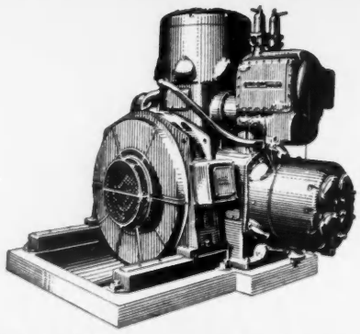

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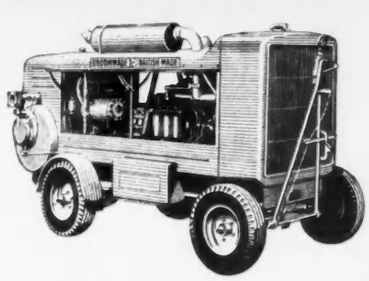

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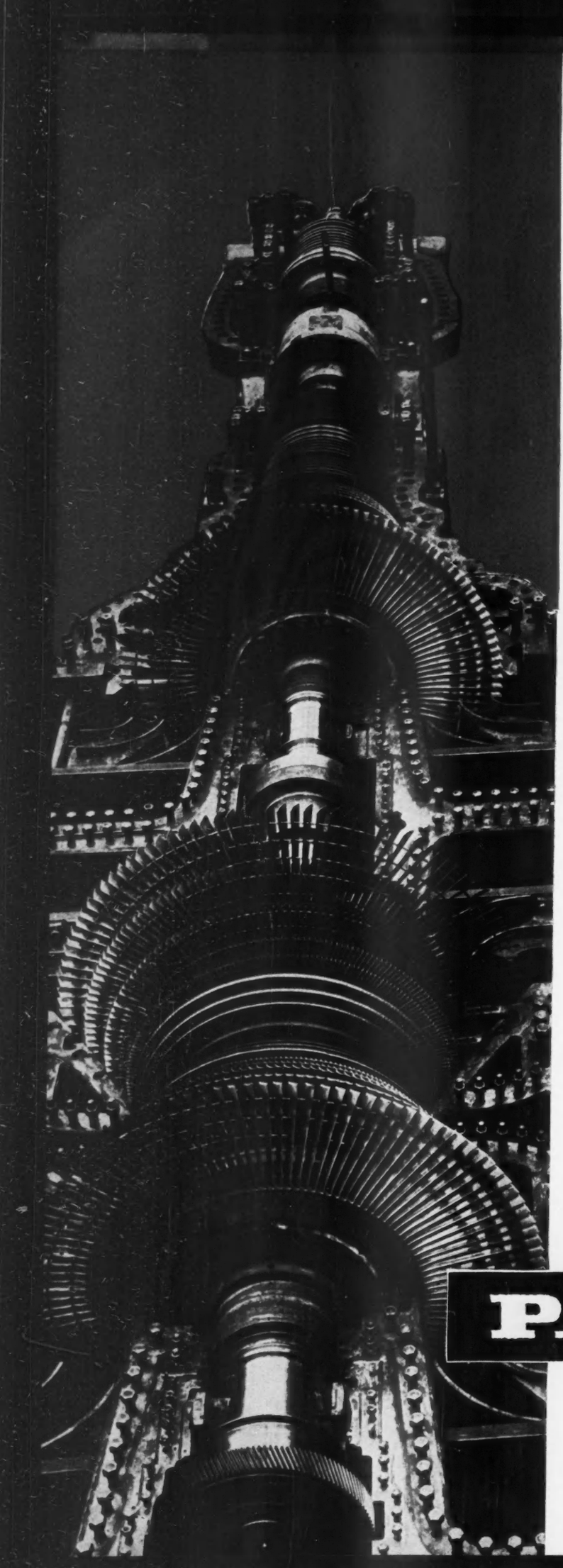

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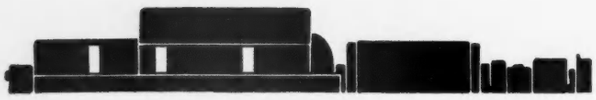

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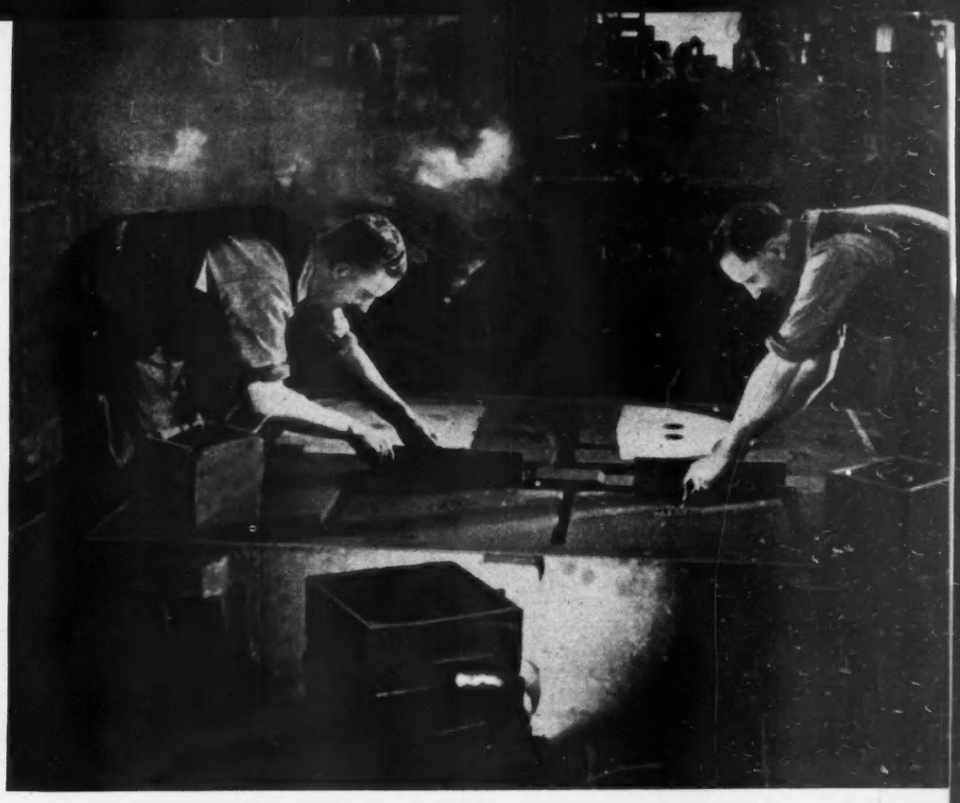

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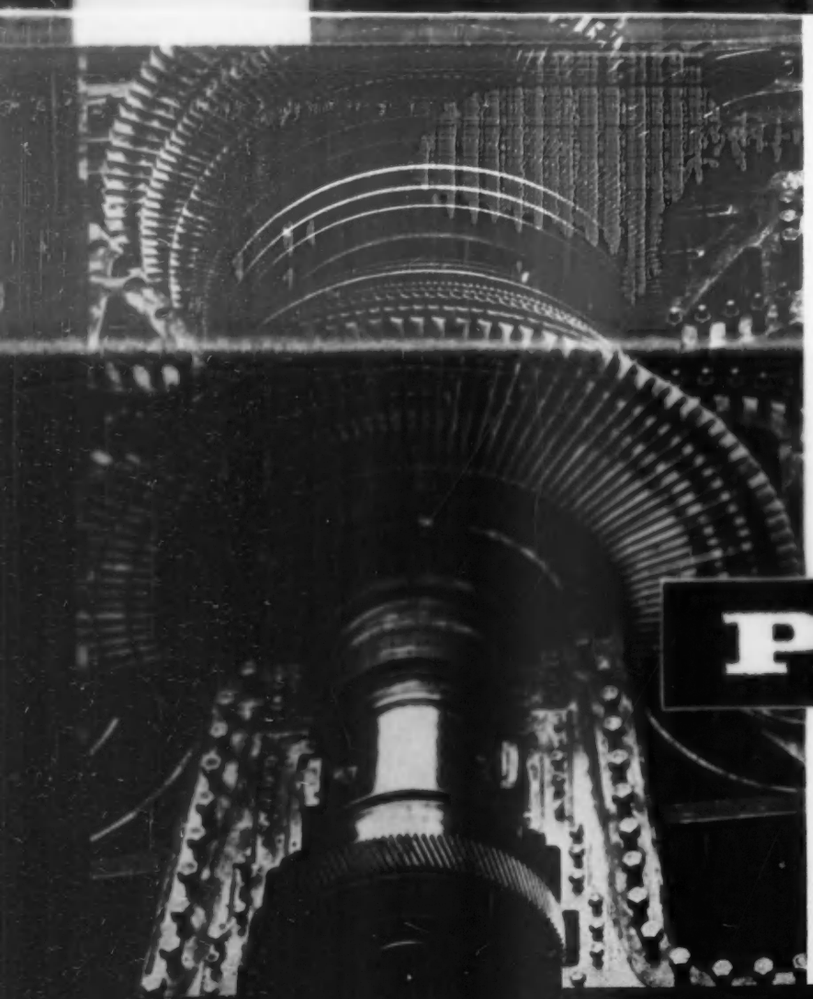

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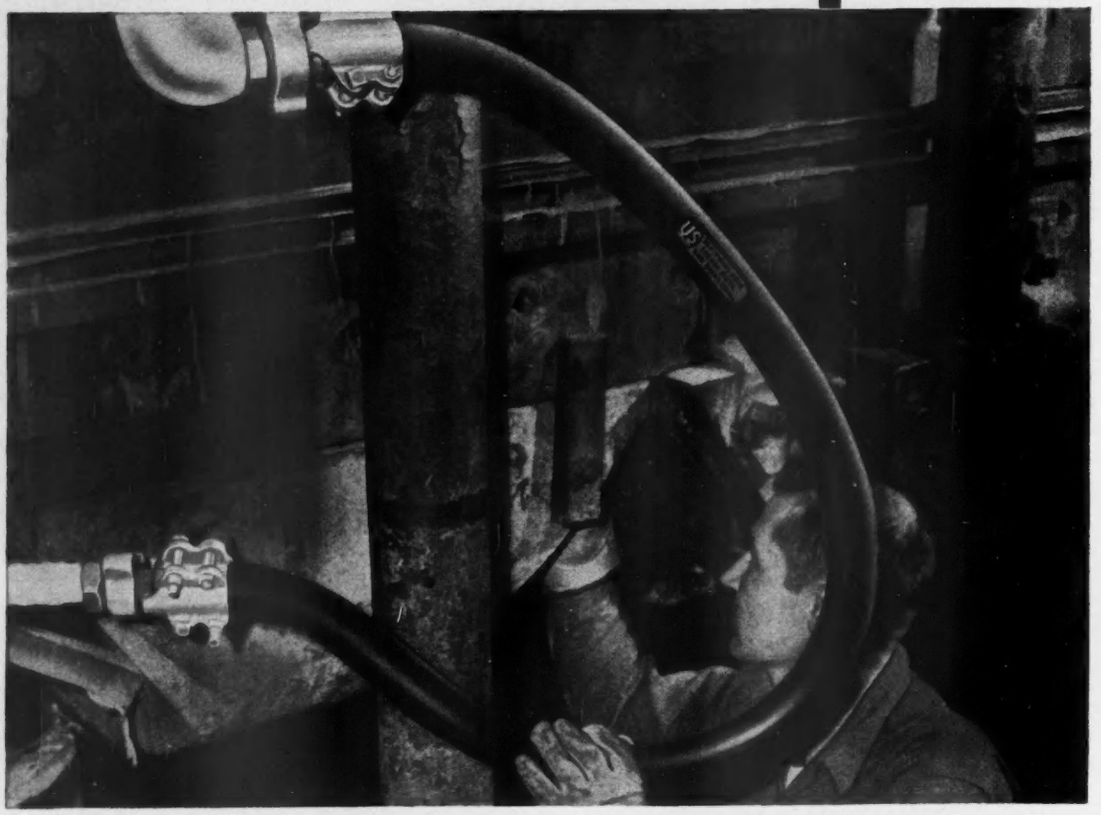

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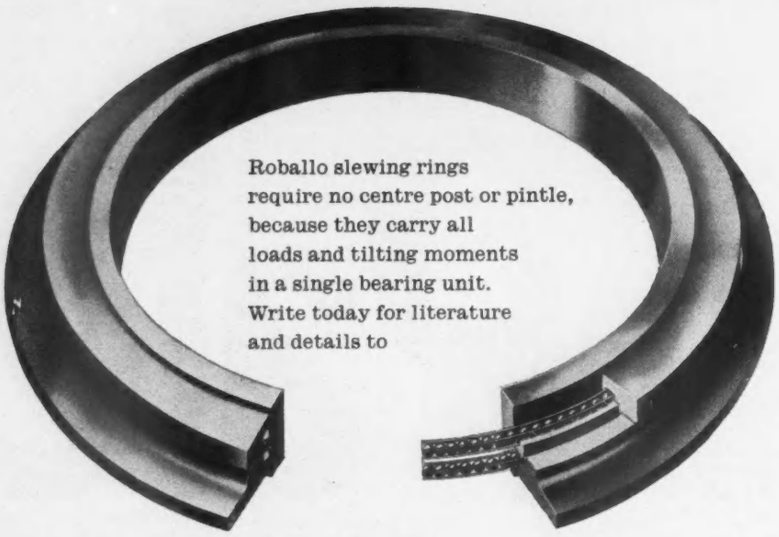

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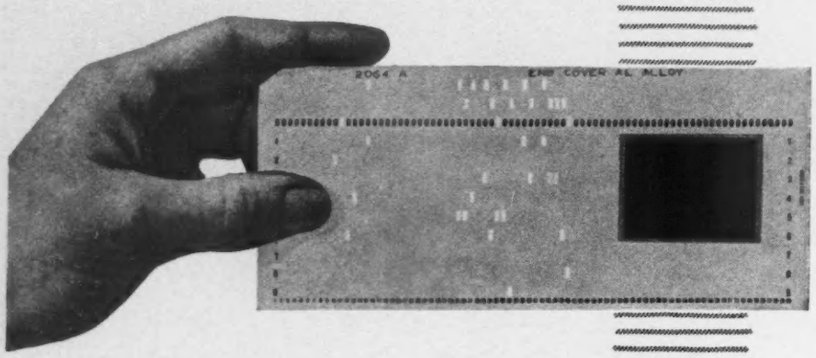

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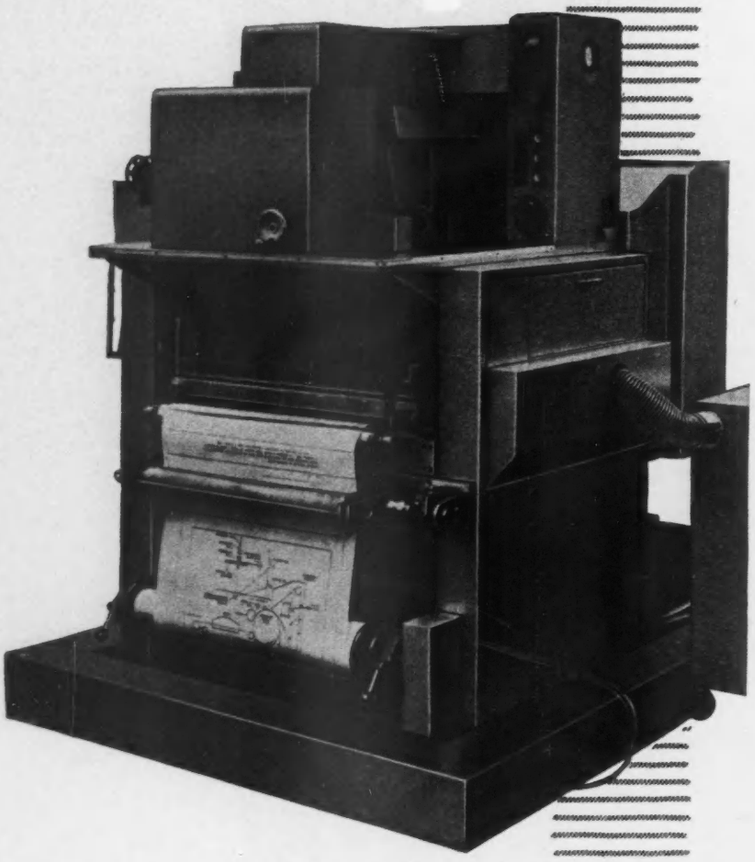

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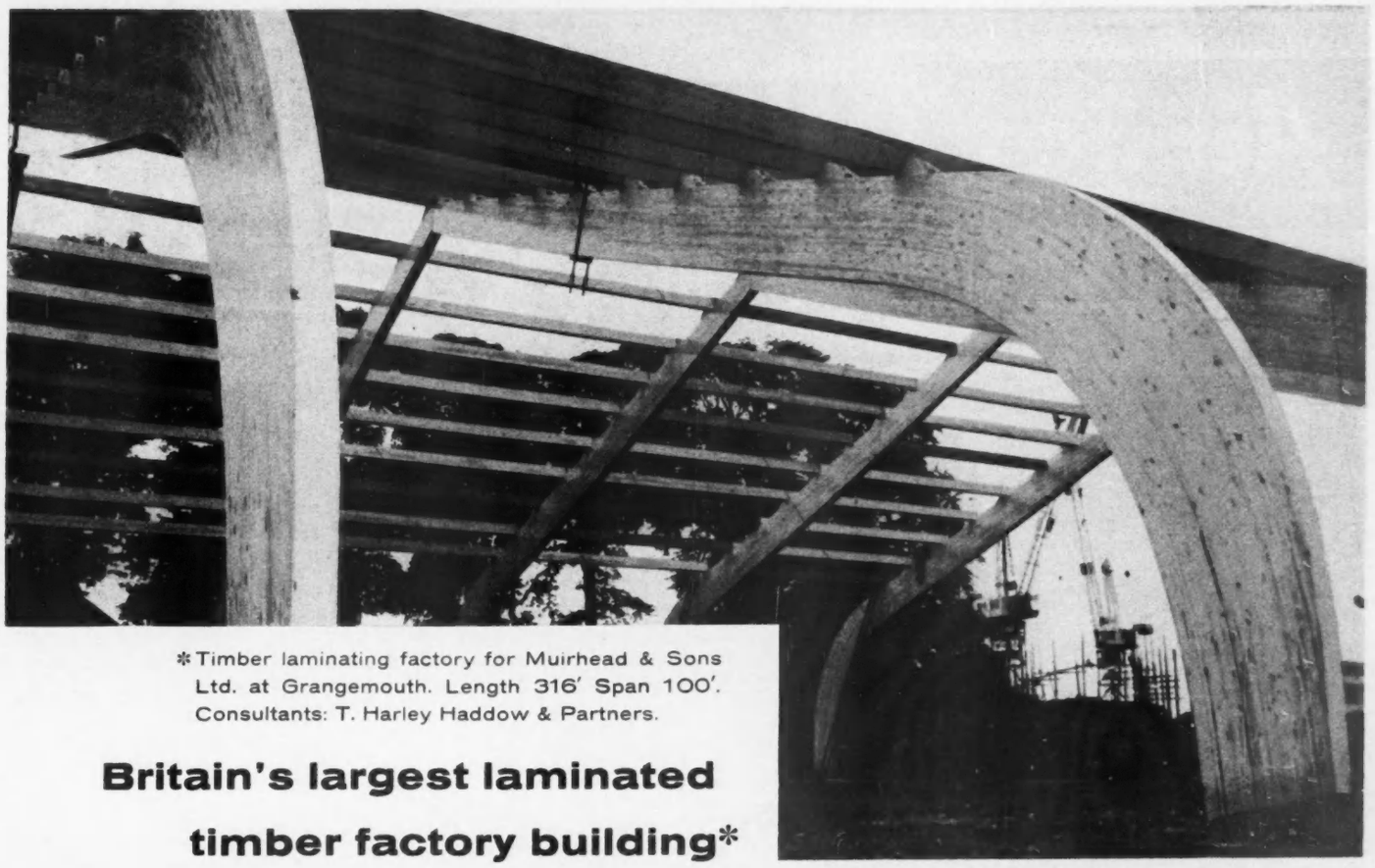

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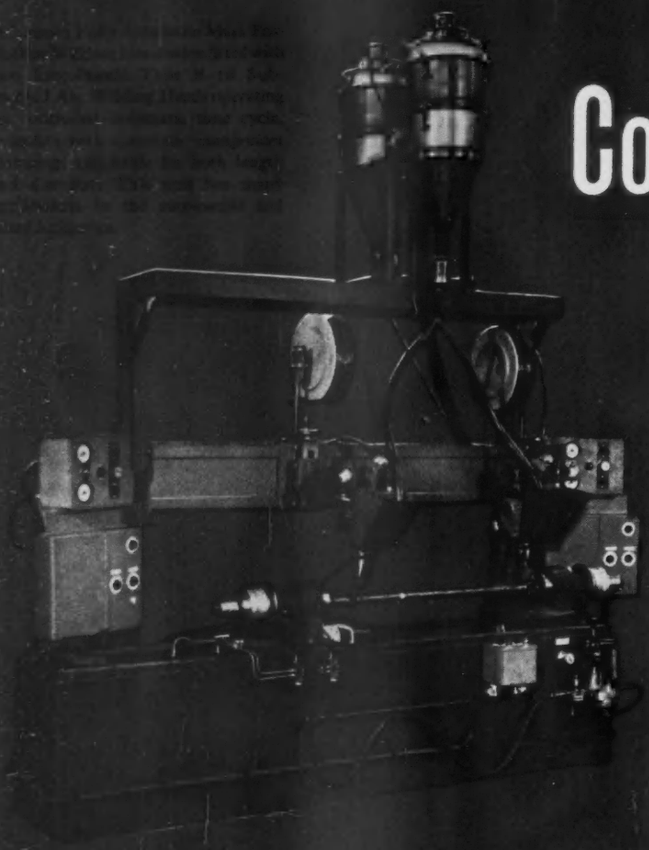

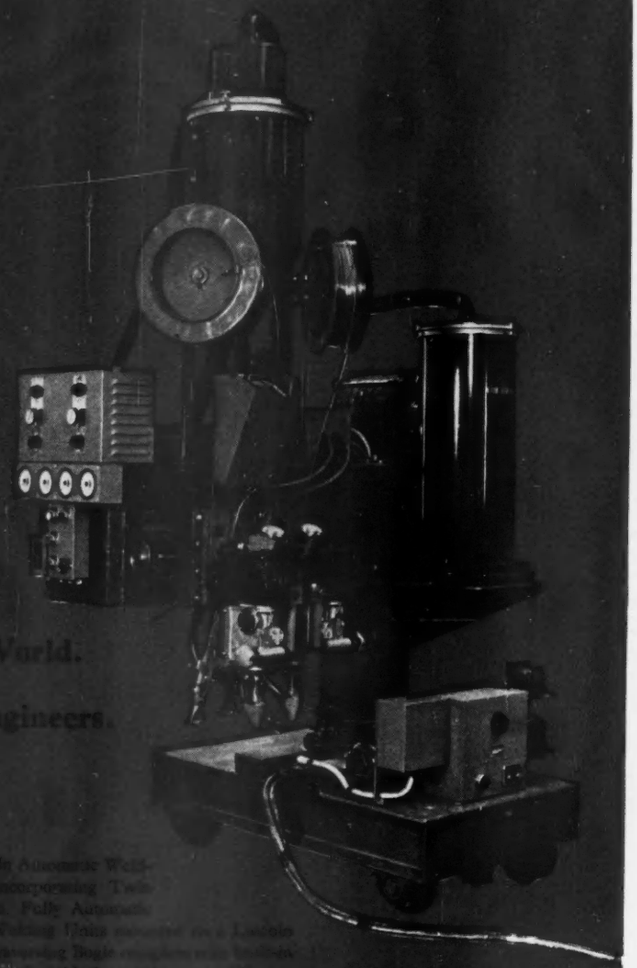

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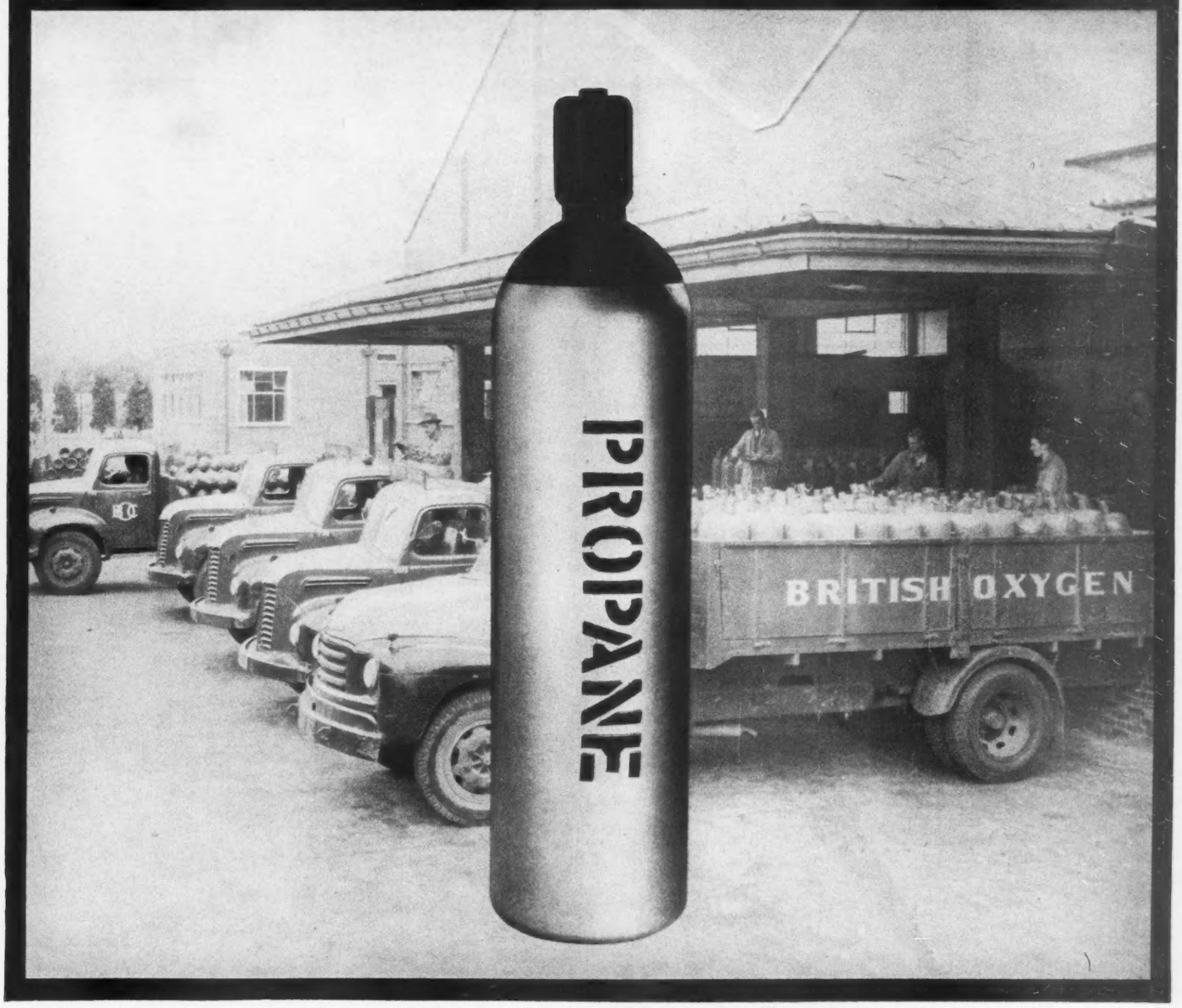

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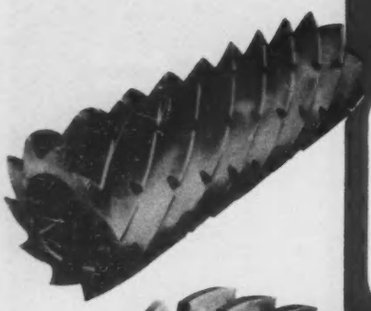

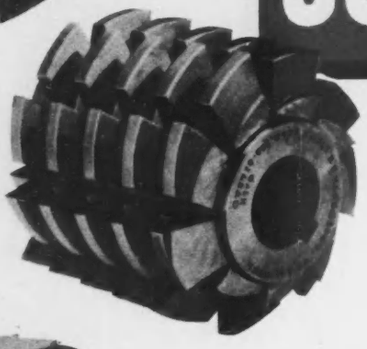

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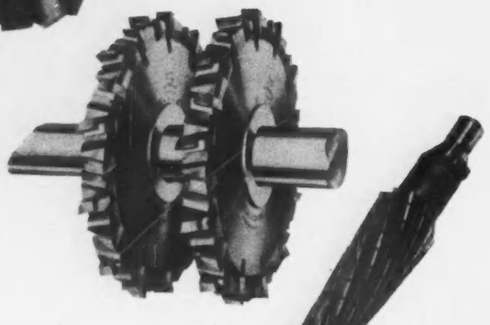

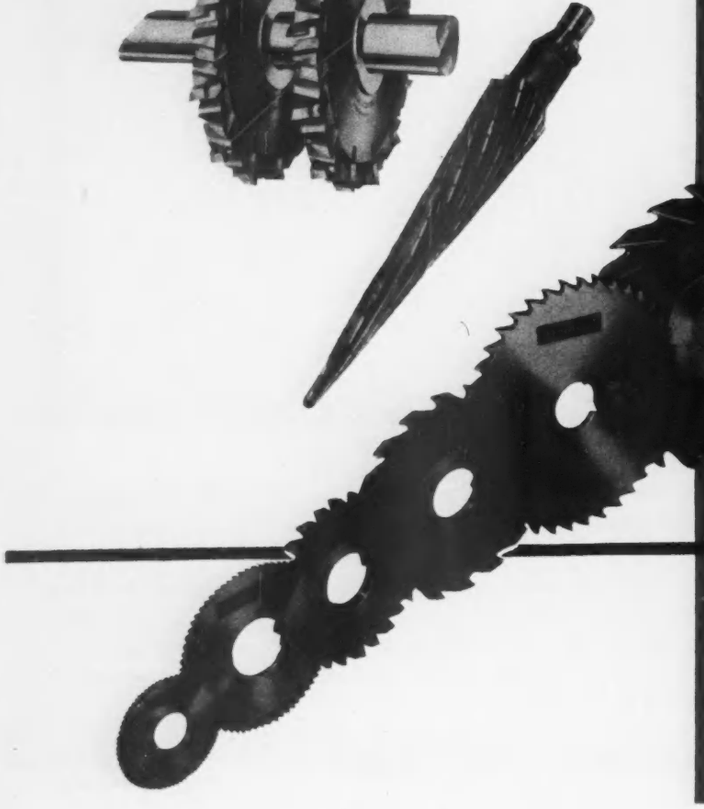

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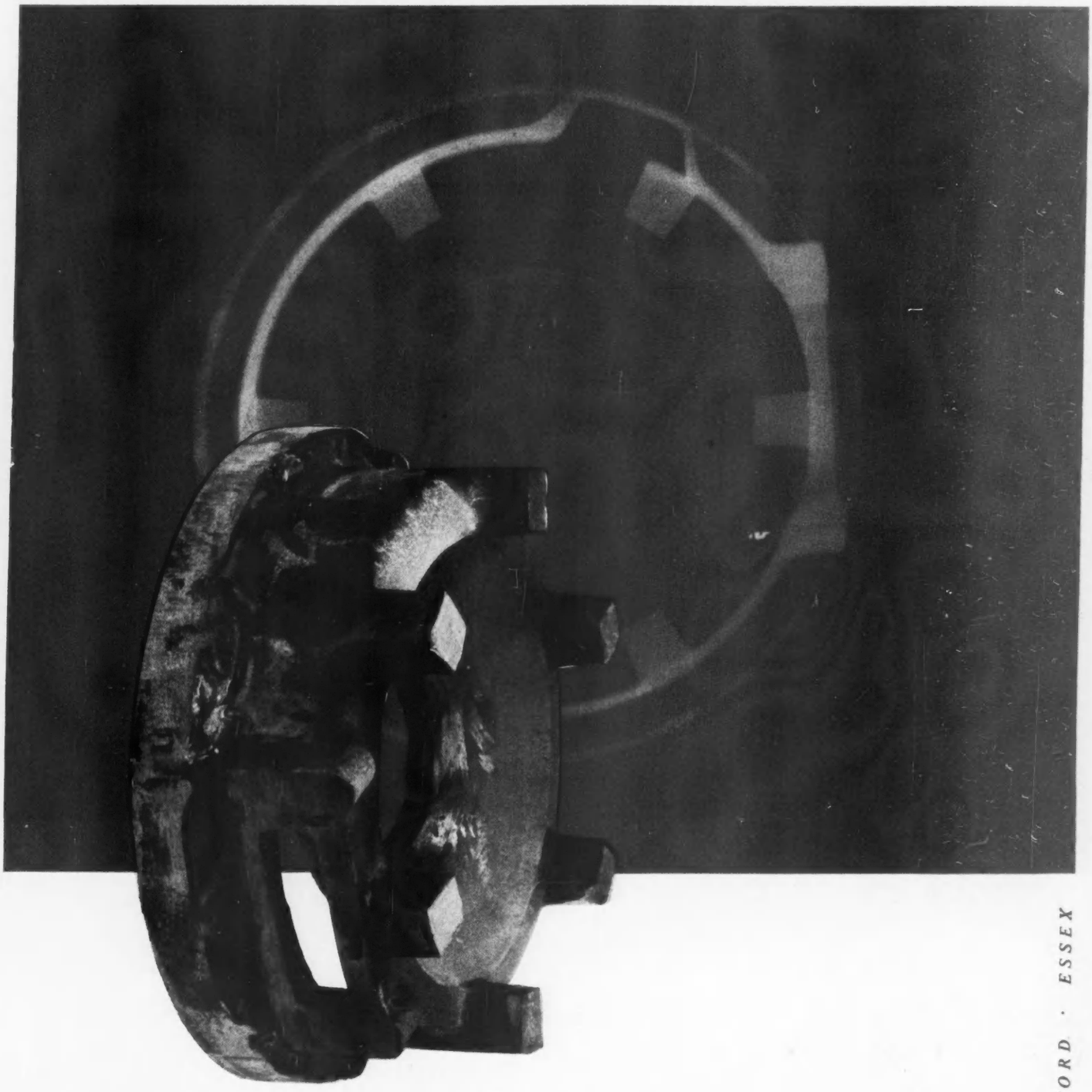

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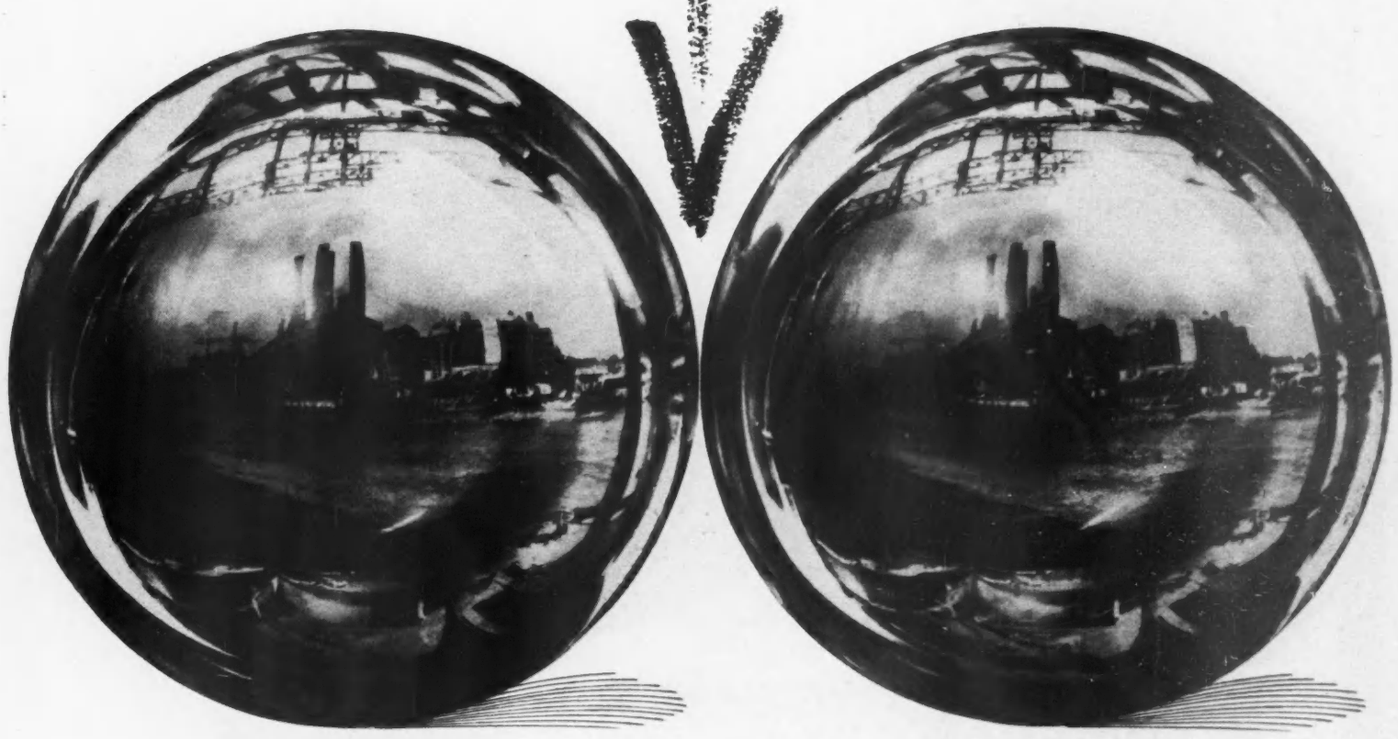

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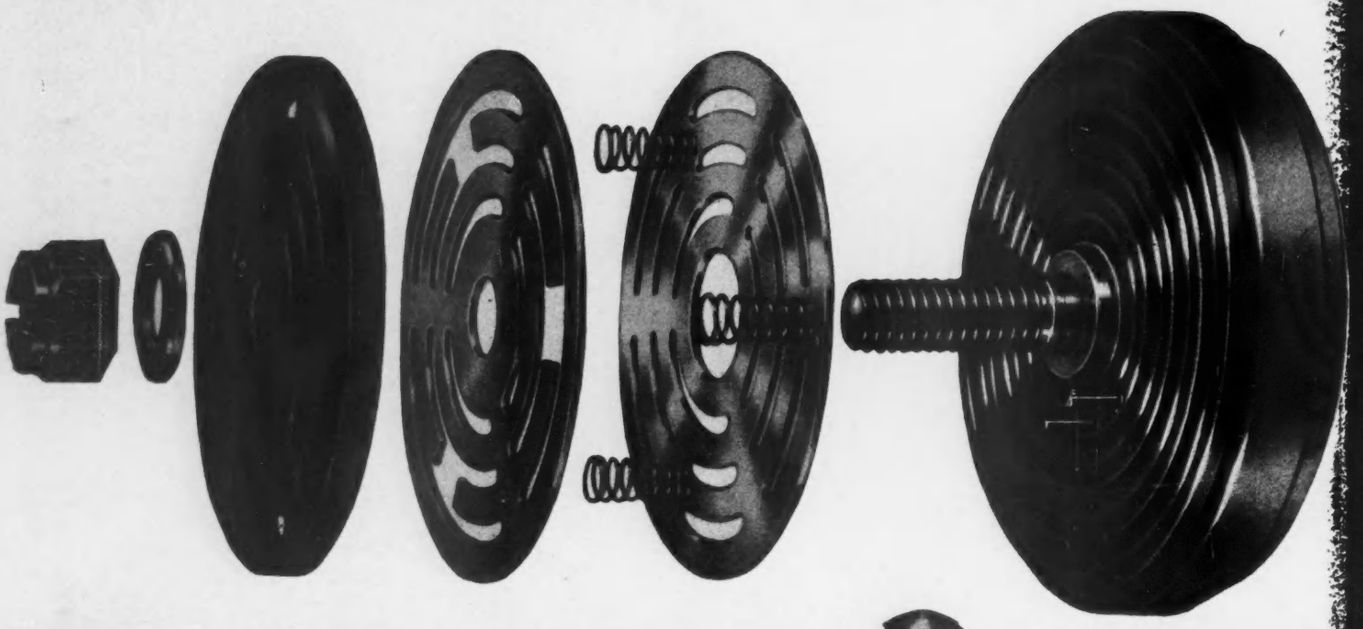

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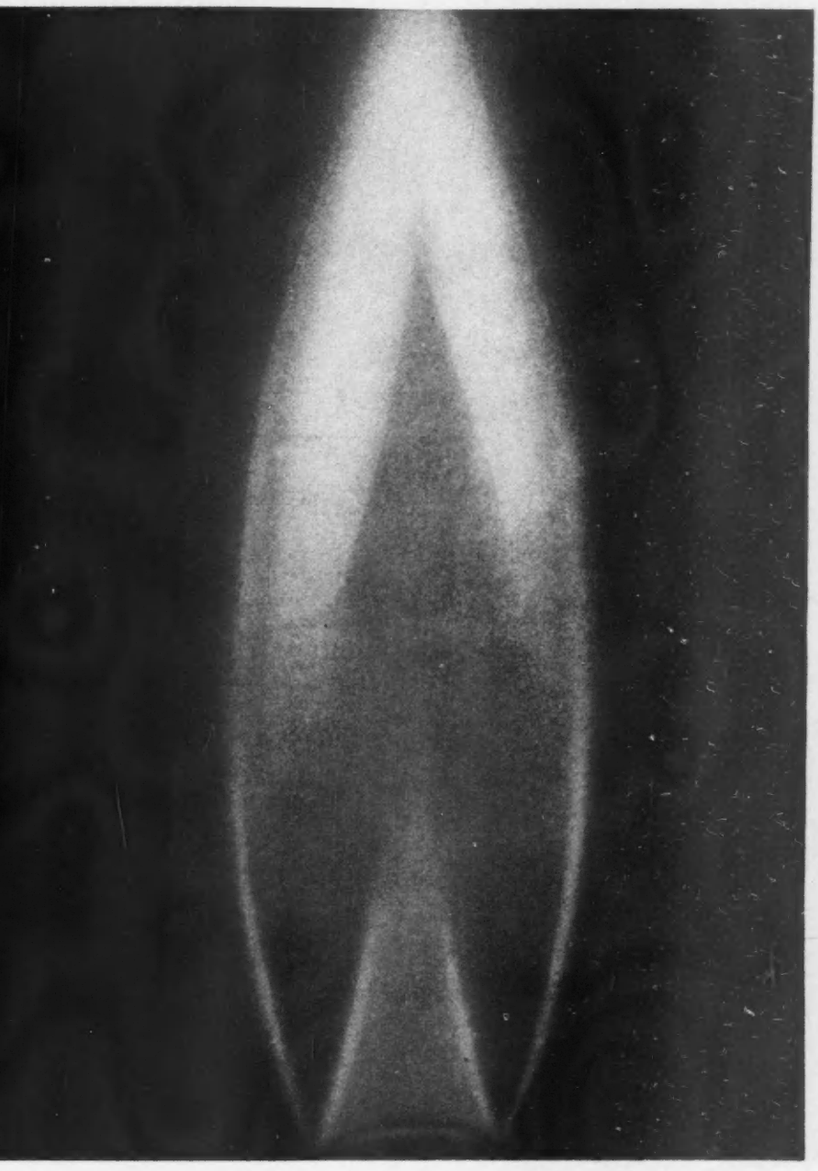

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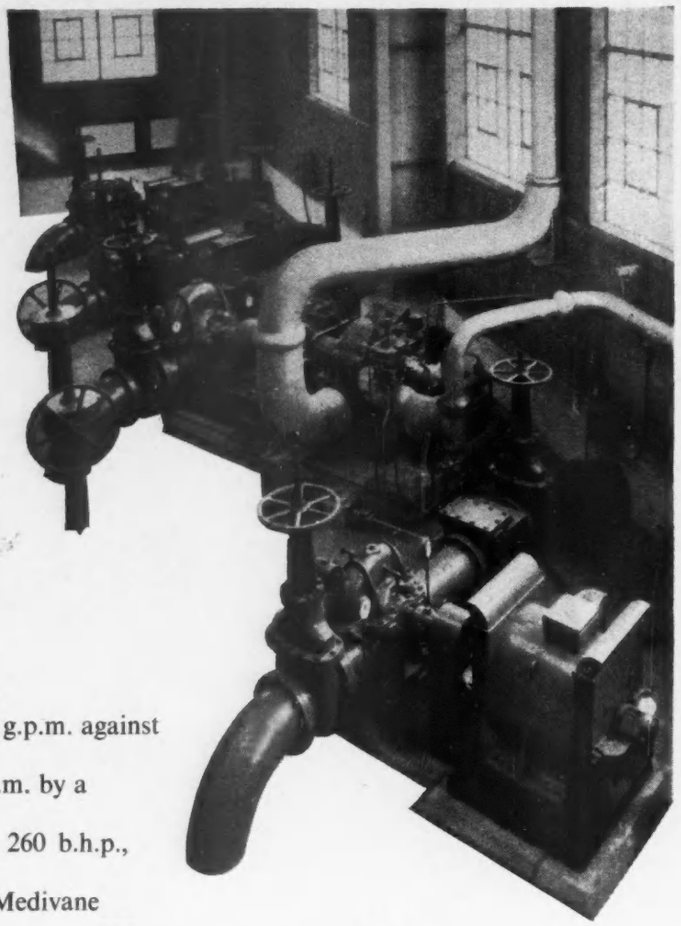

Mather & Platt pumps and motors on furnace cooling duty in the pump house of a large steel works. In the foreground is a 12″/15″ Medivane delivering 4,500 g.p.m. against a 140 ft. head and driven at 1,470 r.p.m. by a drip-proof squirrel-cage motor rated at 260 b.h.p., 2,750 volts; next to this is a 16″/20″ Medivane driven by steam turbine, and in the background are two 17″/20″ Lonovanes driven by drip-proof squirrel-cage induction motors.

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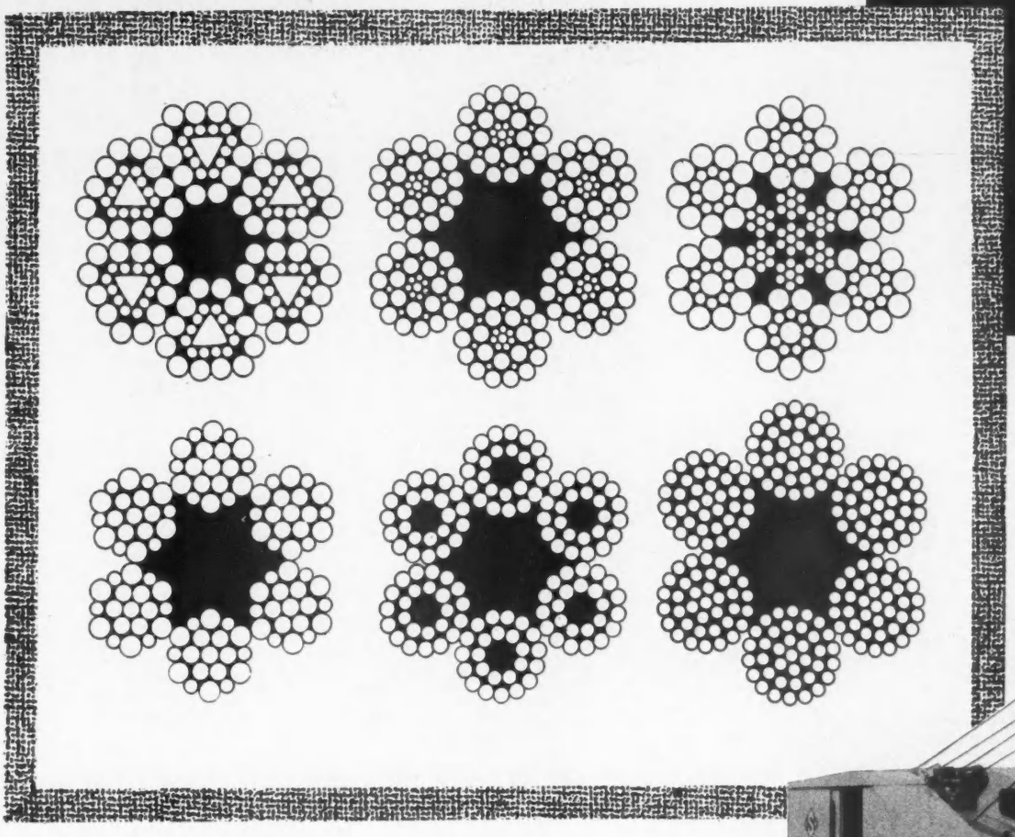

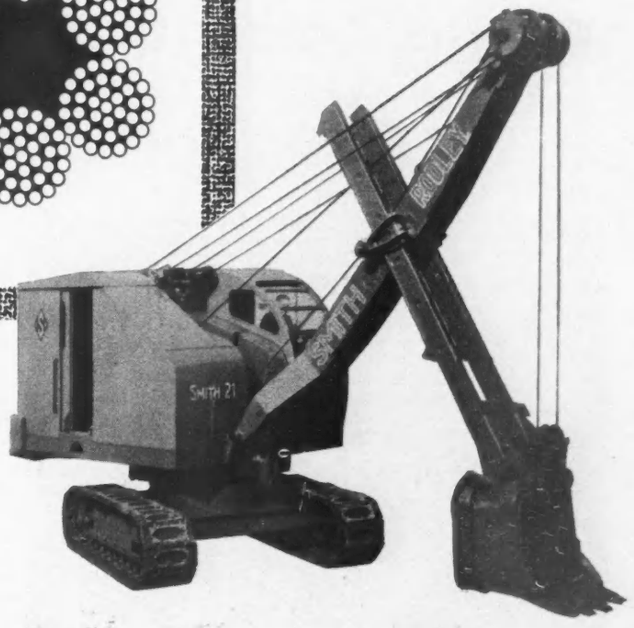

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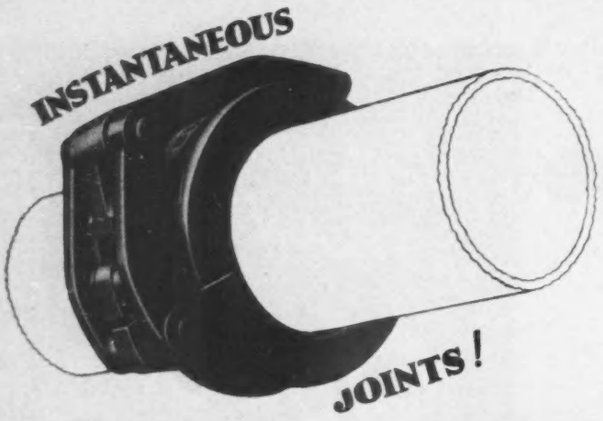

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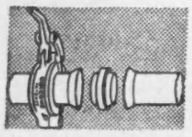
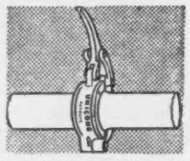
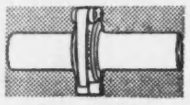

Rubber gasket in position and joint ready to pull over


Pipe ends joined ready for locking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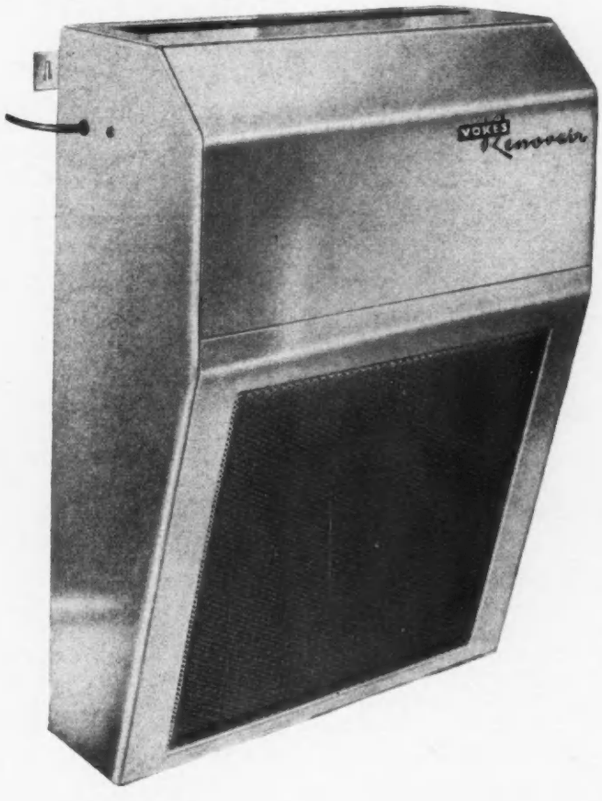

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These photographs of X-ray images of (*a*) iron; (*b*) copper; and (*c*) nickel, compared with (*d*), an optical image at a similar magnification, were taken during a preliminary examination of the micro-structure of a copper-nickel-tin-iron alloy. They show a dendritic crystal which consists largely of iron set in a matrix which is mainly copper.

We are indebted to Dr. D. A. Melford and his colleagues at the Tube Investments Research Laboratories for their courtesy in allowing us to use the photographs.

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Choice of three cross-sectional shapes in white or black rubber. Easily fitted to metal or wooden bodies. Preformed corner pieces avoid mitred joints and give maximum protection where most needed.

Goodyear Loading Bay Fender Units
Made from heavy-duty D section and supplied complete with mounting bracket. Combination of projection and spacing ensures effective operation. Design of units prevents damage by vehicles settling on fenders during loading.

GOODYEAR

VEHICLE AND LOADING BAY FENDERS

THE GOODYEAR TYRE & RUBBER COMPANY (GREAT BRITAIN) LTD · WOLVERHAMPTON

ENGINEERING Impact

of Wage Pressures and Import Prices

Two promising factors for the future of the United Kingdom's economy, and two that are disturbing, are pointed out by the report surveying the last 18 months drawn up by the Organisation for European Economic Cooperation.

Because the pent-up consumer demand is perhaps now satisfied, some slackening in the hire purchase lending and in the increase in spending on durable goods is predicted. This should have the double effect of easing the pressure of imports and making it more important to manufacturers to go after export markets. The report also points to the existence of some unused capacity, both of men and machines, on which further improvements in production, based on better output per man-hour, could be based.

Less optimistically the report observes that the comparative restraint of union wage claims in the past 18 months is coming to an end. This may not square with the engineering settlement for a shorter working week (or more overtime pay, depending on how you look at it) but it may be made very much more true as union negotiators are pressed from behind to "get at least what the railwaymen got."

The second not so reassuring factor is the possibility that there will be some rises in import prices. The success with which rising production and consumption has been matched by price stability has been markedly assisted by the fall and levelling off of raw material and other import prices.

The OEEC report finds the most significant factor limiting expansion may well be a lack of workers. In the longer term the increase in the working population as the post-war bulge leaves school could be used to bring about a marked improvement in total production.

If the OEEC report signposts a particular danger spot it is the summer of this year. A strong increase in private investment, if declared intentions turn into hard orders, coupled with continued growth in other forms of demand could lead to demand outrunning supply.

Old Towns into New Communities

The next wave of New Towns should be further from the "parent" cities than those begun after the Second World War. The sort of distance the Town and Country Planning Association has in mind is upwards of 40 miles.

The Association has submitted proposals to the Government that more New Towns are a matter of urgency in dealing with the difficulties of the major urban centres. The degree of public concern on New Towns has often tended to fall off after London, Birmingham, Manchester and Glasgow have been considered but equally pressing needs for New Town development exist for such cities as Sheffield.

Mr. Peter Self, vice-chairman of the executive committee of the Association, has said that the committee have in mind more than 20 existing small towns which they believe could usefully be expanded into New Towns. There are strong reasons for believing that it is in this way, and not by creating New Towns on virgin land, that fresh communities will in future be created.

While for a variety of reasons the Association declines to name the places it has considered—it is prepared to identify them to the Minister of Housing—six of them are related to Greater London. Of those six, two are towards the West Midlands and would draw their families from Birmingham.

Encouragement of the private builder in New Town building is urged.

The LCC and Town Expansion

The London County Council is something of an old hand at expanding outlying towns. The rate of progress under the Town Development Act of 1952 may have been snail-like but it is in the right direction and the tempo may increase now that the example is there.

2,373 London families, that is about 8,000 people, have found jobs and homes at Aylesbury and Bletchley, Buckinghamshire; Haverhill, Suffolk; Luton, Bedfordshire; Thetford, Wiltshire; and Swindon, Wiltshire.

New developments are going on at Ashford and Edenbridge, Kent; Basingstoke, Hampshire; Bury St. Edmunds, West Suffolk, and at Huntingdon. Agreement has recently been reached for the extension of the expansion schemes at Thetford and Luton. Thetford may eventually expand to another 10,000 people.

Industrial sites, with homes for the workpeople, are still available also at Aylesbury, Bletchley, Haverhill and Swindon.

The Industrial Centre of the LCC has seen the representatives of 1,350 firms, 220 of which have given serious thought to transferring their activities to the expanding towns. So far 39 London firms have moved or made the decision.

Overdrafts and Industries

The Government's intentions to lend well over £100 million to the steel industry, many more millions to the car firms, and to put untold millions into the new aviation groups are all well known.

Less well known is the exact degree of support for British industries from the banks. The recent quarterly analysis of advances by the Clearing Banks, issued by the British Bankers' Association, shows that only the agricultural industry leads the engineering industries in the level of bank advances.

Agriculture's indebtedness to the Clearing Banks had risen by last month to a grand total of £318,789,000, which was £65 million more than twelve months before. Advances to the engineering industries by last month had reached £318,286,000, an increase over the year of £46 million. Both agriculture and engineering have received 9·8 per cent of the banks total advances to companies, public authorities, and individuals of £2,828,453,000.

At February, 1959, the engineering industries owed a higher proportion, 11·0 per cent of the total. Agricultural advances also represented a larger slice of the national overdraft to the clearing banks, 10·3 per cent, a year ago.

Where have the increases gone?

Personal and professional advances are up from 17·7 to 19·7 per cent. Hire purchase and finance companies from 2·4 to 3·9 per cent and retail trade from 9·5 to 10·4 per cent.

of Modernisation Upon Railway Productivity

The reasonable return expected from railwaymen when implementation of the Guillebaud report brings their rewards more into line with other occupations is that the "productivity" of the rail services shall rise to meet the needs of an expanding economy.

The British Transport Commission keeps in touch with the operators of foreign railroads and what is achieved overseas is a valuable measure and guide to the success of efforts at home.

The current report published by the European Productivity Agency on productivity in nine main European networks shows that between 1950 and 1957 the index of locomotive productivity was raised by 52 per cent. The increasing use of electrically powered locomotives and the improvement of track equipment, enabling heavier stock to run faster, were the two principal reasons for the advance.

The nine networks were those of Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden and Switzerland.

Rising locomotive productivity was matched by a 41 per cent increase in labour productivity caused by constant reductions in the total number of hours worked by the rail staffs and the overall increase in traffic. Although the upward rise in total freight and passenger traffic was interrupted in 1952, 53 and 54, the level at the end of 1957 was 29 per cent above that of 1950.

At the same time as this increase in traffic was being secured the railways' consumption of energy fell by 6 per cent as the change from steam to diesel and electric traction was carried through.

This is plainly a picture of an industry with vitality and faith in itself. It may not be able to escape from the railways direct relation to the economic health of its country but it shows what within that limit can be done in increasing efficiency.

A Vigorous Sales Policy for Coal

Now that the details are available of the fighting entry by the National Coal Board with a loans scheme into the market for domestic, office, and small industrial central heating by solid fuels it is clear that the coal industry has a strong chance of reclaiming lost ground.

One of the reasons paraffin burning portable equipment entered so many homes was the low cost of the heaters and their modest fuel bills. Since the Coal Board, working with Forward Trust, a finance house owned by the Midland and Clydesdale and North of Scotland Banks, is prepared to allow a £20 appliance to be paid for over two years (5*s* a week) and without deposit, the cost advantage of other forms of heaters available on hire purchase through shops largely disappears.

Electric, gas and paraffin heaters are widely displayed at places where the greatest number of housewives assemble. It remains for the Coal Board, through their advertising campaign, and perhaps by seeing that stoves and modern fireplaces are well displayed in the shops, to make the safety and cheapness of coal burning widely felt.

For the more ambitious central heating system—say a boiler giving hot water for general use and seven radiators and costing £380, or £2 a week for five years—there is a price advantage over oil installations.

Whether, as Mr. R. H. E. Thomas, a Coal Board director, has said, the cheapness of coal for heating the home makes it unfashionable and so robs it of snob appeal is hard to determine. What is likely is that the householder, aware of the endlessly increasing burden of rates and costs, will quietly decide that fashionable or not he can now afford, thanks to the NCB loan scheme, to install the cheapest of the rival systems.

and Repairs and Tax

Income Tax Law allows for deductions to be made for sums expended in repairing business premises, and in most cases it is fairly easy to decide what is, and what is not, a repair. But there are cases which give rise to disagreements, and Mr. W. F. Curtis has prepared for the Income Tax Payers' Society a short guide to the principles upon which relief is based.

In a law case quoted, a colliery company had replaced an unsafe chimney stack with a new and improved one, and had claimed as a deduction part of the cost. This claim was rejected, on the grounds that the work done was not a repair; it was simply a replacement.

It seems that the position can be summed up by saying that where there is complete rebuilding of the entirety, no repairs allowance can be claimed. This covers the question of "notional" repairs, that is, the cost of the repairs which would have been necessary if the rebuilding had not taken place. It should be added that what is considered to be an "entirety" may be a matter for argument. With regard to alterations, as distinct from replacements, it is the usual practice to allow a deduction for the proportion applicable to repairs. Costs of making good dilapidation at the expiry of a lease are allowed, and this, it appears, may include sums paid as compositions for the dilapidations.

Further legal questions are involved in the case of repairs carried out by successors to a business. It has been argued that when a change of ownership takes place the legislation regards the trade as discontinued for all purposes at the date of the change of ownership. On the other hand, recent court cases give support to the opposite argument. This holds that the test laid down in section 137 (*a*), Income Tax Act, 1952, refers to the trade itself and not to the person carrying it on at the time. If this is correct, expenditure on repairs to an asset in use during a previous ownership of the business is allowable to the present owner who has actually incurred the expense.

Rubbers, Plastics, Metals for Diaphragms

Consider your diaphragm materials carefully. There are many new fabrics and constructions now made, and correct choice will pay off in better sensitivity and longer life.

To get the best performance from a diaphragm it pays to consider, in collaboration with a diaphragm manufacturer, all the factors set out in the box. Diaphragms are used in many devices, including valves, pumps, pressure monitors, valve actuators and flow meters. For valves and pumps where the diaphragm is driven mechanically, the sensitivity to pressure variations need be low, but for most other applications it pays to have as light a diaphragm as possible consistent with the maximum pressure encountered. Sensitivity is then high and hysteresis low.

Choose Sheet or Surfacing Material According to

- Top temperature for stability
- Bottom temperature for elasticity
- Chemical resistance
- Modulus of elasticity
- Variation of elastic properties with temperature
- Fatigue resistance
- Porosity and gas permeability

Choose Reinforcement and Design According to

- Pressure differential
- Sensitivity
- Diaphragm travel
- Linearity of response
- Adhesion to coating and resistance to flexing
- Ease of forming
- Ease of sealing

Reinforcements

Diaphragms can be unreinforced or reinforced, from single sheet or duplex. In the table are shown the most common composite materials. Nylon or polyester reinforcement provide good strength to weight compared with cotton, and moisture resistance is also improved. Polyester fibres, especially, have good dimensional stability and are heat resistant. Nevertheless, linen is still widely used for general purpose diaphragms, and rubber coatings adhere to it well. This problem of adhesion during flexing upsets glass fabric, but it is still much used as the basis of high temperature diaphragms, especially with a ptfe coating.

Elastomer Coatings

Natural rubber is used as a coating, but some of the synthetic rubbers have greatly improved resistance to chemicals and heat. Neoprene was the first rubber resistant to oils. Nitrile synthetic rubber was developed when aromatic or coaltar-derived solvents and oils became widely used. It is also useful for low temperatures. The silicone rubber polymers, butyl synthetic rubber, polyacrylate rubber, Hypalon and Viton fluorocarbon elastomers are some of the newer coatings used.

Neoprene has excellent resistance to oils and aliphatic hydrocarbons though aromatic solvents cause it to swell considerably. Its resistance to the corrosive actions of chemicals is excellent. It has good heat resistant properties up to 120° C which is not quite so good as Hypalon. It is now used as the facing for diaphragms on compressed air, and widely for handling radioactive services such as heavy water and argon in connection with nuclear work.

SBR or GR-S is the low cost synthetic rubber. It has about the same resistance to solvents and chemicals as natural rubber and is slightly better in resistance to heat and ageing. In abrasion resistance it is good.

Nitrile rubber consists of a copolymer of butadiene and acrylonitrile. The acrylonitrile content can be varied; as it increases, resistance to oils and solvents goes up, but low temperature flexibility is impaired. These polymers have excellent resistance to petroleum oils and fuels and good resistance to mineral and vegetable oils, but they swell considerably when immersed in oxygenated solvents such as acetone. They have good resistance to acids and bases with the exception of those having an oxidising action. The polymers have good heat resistance and good low temperature flexibility when plasticisers are incorporated, but abrasion resistance is low.

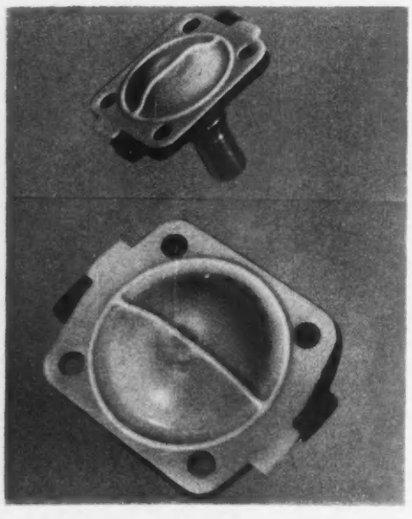
Nitrile rubber with rayon reinforcement is widely used for manufacture of automotive fuel pump diaphragms, and similar material with cotton reinforcement is used by manufacturers of aircraft fuel systems. Many general purpose instrument diaphragms incorporate nitrile rubbers, and it has been tested successfully on cotton for use as a gas meter diaphragm operating on town's gas.

Butyl rubber has the poorest resistance to petroleum oils and fuels of any of the rubbers. It has excellent resistance to corrosive chemicals, vegetable and mineral oils, acetone, alcohol, phenol and ethylene glycol and water. It has fair low temperature properties and abrasion resistance and is outstanding in its resistance to permeability of most gases.

Hypalon was at first used relatively little, but its diaphragm outlets are fast expanding. It has unparalleled ozone resistance as well as resistance to oxidising chemicals, abrasion and flex cracking. Hypalon is quite heat resistant—with a maximum of 180° C. It can be compounded for good low temperature flexibility and low moisture absorption.

Coating	Fabric substrates				
	Cotton	Nylon	Polyester (Terylene)	Glass	Ptfe
Neoprene	★	★		★	
Nitrile ..	★	★		★	
Butyl ..	★	★			
Hypalon ..		★	★	★	
Acrylic ..			★	★	
Silicone ..			★	★	★
Viton ..			★	★	★

Above: Common fabric constructions.
Below: Composite rubber/ptfe valve diaphragm.



Reinforced Hypalon has been used in a proportioning pump which feeds sulphuric acid to towers where this chemical is used to desiccate wet chlorine. This diaphragm flexes through 0·25 in stroke at the rate of 26 times a minute and comes into contact with wet chlorine at the edges. Replacement was recommended after 6 months but it has now stood up for 4 years.

Acrylic rubber has good resistance to oxygen and ozone and offers heat resistance properties between the best of the conventional rubbers and the silicone and fluorocarbons. The service temperature range is usually considered between −20 and 150° C and most usage has been where exposure to hot hydraulic fluids or oils is expected. It has rather poor resistance to alkalis, acids, aromatic solvents, alcohols and other hydrocarbons containing a hydroxy radical.

Silicone rubbers have been in use for some years. Although limited in strength, they are outstanding for temperature resistance—between −65 and 200° C. Their tear strength and abrasion resistance are poorer than most of the other synthetic elastomers. Resistance to solvents, jet fuels and oils is not good although polymers of the fluorosilicone type overcome this shortcoming.

Polysulphide rubber is one of the outstanding polymers for resistance to the swelling actions of oils, greases and solvents, including aromatics. In the coated fabrics industry in America it is often found in gas meter bellows.

Viton has outstanding resistance to a wide variety of oils, fuels, solvents (including aromatics) and chemicals. Its useful temperature range is from − 40 to 230° C but it can be used for short intervals in temperatures from 300 to 320° C. It has poor resistance to the swelling action of low molecular weight ketones and some low molecular weight esters.

Plastics

Ptfe is useful over a wide temperature range, but it is really too rigid to be ideal and has a transition point around room temperature which is reflected in a sudden change in the Young's modulus/temperature curve. Thus unless the diaghragm stiffness is very low compared with its mating spring, the combination may show instability which is not acceptable in instrument design. Nevertheless, the material is very popular, and the high modulus can be overcome to some extent by corrugations. By special moulding techniques, the screw attachments can be fully moulded in position in a diaphragm.

One instrument maker has recently changed over from ptfe to Viton in a control used to meter alkalis, amines, hydrocarbons, and dilute or concentrated mineral acids. Viton gives better long term stability of measurement and higher stability under varying temperatures.

Ptfe is backed with synthetic rubber in the valve design of one manufacturer (see illustration) and hopeful results have been obtained in composite Be-copper/ptfe combinations.

In the reinforced form, one of the most successful combinations of ptfe is with fibrous glass fabrics, made by impregnating or coating the glass fibre cloth with ptfe dispersion. These will withstand pressure differentials of up to 100 lb per sq. in, and the glass fabric reduces cold flow around the clamped periphery.

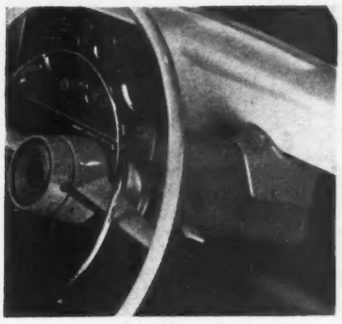
Polyester film resists oils, fats, industrial solvents and most chemicals except strong alkalis and phenols. It has low water vapour and gas permeabilities. It can be used alone or laminated with conventional materials such as

Steering Column Fairing in Polyethylene

News that the 1960 Hillman Minx has an attractive steering column assembly which incorporates a plastic fairing came just too late to be included in the "Plastic Moulding for Cars" (ENGNG., 4 Mar. '60, p. 311). The emphasis there was on use in the USA—this is British.

The fairing is made by Ketch Plastics in grey high density polyethylene supplied by British Resin Products. For such non-load bearing trim in cars, plastics are admirably suited. In this application the makers comment that high density polyethylene is strong and rigid and has a high degree of resilience which enables it to be sprung on over the main steering housing and retained in position by two screws without any possibility of rattling or drumming.

"Rigid and strong" can be misapplied and misunderstood only too easily with plastics when comparing them with other materials. Take a mild steel—modulus of elasticity 29×10^6 lb per sq. in with a density of 7·8. How does this really compare with high density polyethylene—modulus about $1{\cdot}25 \times 10^6$ with a density of 0·95? If built to exactly the same design in the same thickness of sheet the rigidity of the plastic is one-twentieth that of the steel and has about one-twelfth the strength at 3,700 lb per sq. in.



Polyethylene fairing.

If, however, the wall thickness can be increased to give the same overall weight as the steel item, then the rigidity of the plastic component is increased $\times$ 64, which makes it twice that of steel, and the strength becomes well over half.
British Resin Products Limited, Piccadilly, London, W1.

Concluding **Diaphragms**

neoprene to give added strength and chemical resistance.

Films can be formed to a limited extent, and this increases its usefulness as a diaphragm material. A diaphragm of formed polyester film is currently being used in the SU electric petrol pump.

Irradiated polyethylene is fuel resistant but not suitable below −20° C. Its high temperature performance is better than ordinary polyethylene.

An odd man out may appear to be leather. Nevertheless, techniques of impregnation have increased its scope. The three dimensional weave of fibres gives outstanding heat resistance and flex life is high. An example of its use is for diaphragms in gas meters.

Metals

Metal is seldom used for diaphragm valves because no metal gives the resilience and progressive sealing of rubbers. But for pressure sensing devices they are often used. The most popular are phosphor-bronze, Be-copper and 18 Cr-8 Ni-stainless steel, but one firm at least offers Ni-Span C. One of the difficulties lies in obtaining a good seal around the periphery; soft solder can be used with P-bronze up to 100° C. Be-copper can be soft soldered up to about 100° C and is better elastically than P-bronze. 18 Cr-8 Ni-stainless steel can be argon arc welded for use up to 350° C and so can Ni-Span C.

Be-copper is one of the most outstanding metals because it has high elastic limit coupled with low modulus of elasticity and good resistance to corrosion. Fatigue resistance is high. Further alloys containing small amounts of cobalt allow complicated shapes to be formed in the soft state and after short heat treatment develop a tensile strength of 90 and a proof strength of 65 tons per sq. in.

Help in choice of selected diaphragm materials will glady be given by the following firms, who supplied the information for this article.

George Angus and Company Limited, 152 Westgate Road Newcastle upon Tyne 1.

Crane Packing Limited, Slough, Buckinghamshire.

E. I. Du Pont de Nemours and Company, Wilmington 98, Delaware, USA.

Imperial Chemical Industries Limited, Millbank, London, SW1.

Johnson Matthey Limited, 78 Hatton Garden, London, EC1.

Richard Klinger Limited, Sidcup, Kent.

Saunders Valve Company Limited, Cwmbran, Monmouthshire.

Teddington Aircraft Controls Limited, Nr. Merthyr Tydfil, Glamorganshire.

James Walker and Company Limited, Woking, Surrey.

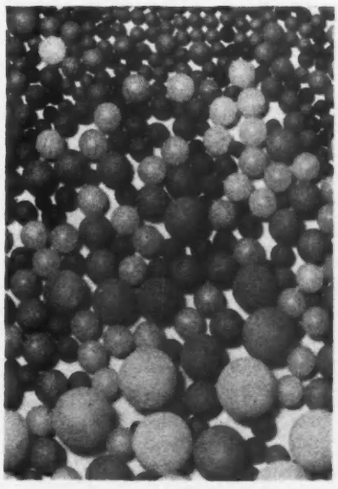
Ready-to-Use Plastic Gelcoat

The method for obtaining a smooth surface in reinforced plastic, in other words without the glass fibres penetrating through to the surface, is to apply a gelcoat of pure resin on to the mould surface, and to allow this to harden before completing lay-up. What, of course, is needed for applying to vertical surfaces is a gelcoat which is thixotropic, which won't flow.

Bakelite have now taken the agony out of the procedure of making up complicated thixotropic mixes by launching a new plastic gelcoat which requires only addition of catalyst and accelerator. Ask for information on DSR 19142.
Bakelite Limited, 12 Grosvenor Gardens, London, SW1.

Precision Plastic Balls

If you have been held up for want of precision plastic balls your big day has arrived. Contact Insley Industrial Supply. These are made mainly from Du Pont plastics and there are seven basic materials to choose from: three grades of nylon, polyethylene, cast phenolic, polymethyl methacrylate, and ptfe. Prices range from the sublime to the ridiculous over a fairly comprehensive size range from $\frac{1}{8}$ to $2\frac{1}{2}$ in diameter. However, for two grades of nylon and ptfe the top figure is a quarter of this (but do check with the makers for exact details).



Balls made in seven plastics.

Tolerances range from 0·001 in on the diameter with 0·0005 in sphericity for the best grade of nylon, to 0·005 on the diameter with 0·005 in sphericity on the polyethylene and phenolic balls.

The makers have a long list of applications which are not just wishful thinking, and include use in chemical and cosmetic milling, check valves, corrosion resistant bearings, and floats.
Insley Industrial Supply Company Limited, 21 Poland Street, London, W1.

Densified Wood Flooring in Vans

Laminated wood flooring made from beech veneers, impregnated and densified under vacuum with thermosetting resins, is now being specified by the London County Council for some of their new school meals vans. This type of flooring was chosen because of its light weight, rotproof and waterproof properties which are suitable for this type of service where the bodies interiors are scrubbed out twice daily. Ten of these 30 cwt. vans are already in service and a further 18 are being built.

Six 3 ton furniture vans are also being built for the London County Council incorporating this flooring material, its resistance against rough usage being the main advantages in this application. These vans serve over 1,500 schools and technical colleges. Cunard Commercial Body Building Company were responsible for the construction of the meals vans on Morris Commercial chassis, while B. Walker and Son built the furniture vans on Austin chassis.

The flooring is sold by Permali under the name Permatred, and the material has properties outlined below.

Properties of Densified Beech Veneer Flooring

Specific Gravity	1·20 gm per cc
Bending Strength	14,000 lb per sq. in
Young's Modulus in Bending	$1{\cdot}7 \times 10^6$ lb per sq. in
Compressive Strength	30,000 lb per sq. in
Water Absorption in 24 hours	Less than 3 per cent

Permatred is highly resistant to petrol, oil, weak acid and alkalis and is also proof against attack by fungus, termites and rodents. While the material is inflammable, the ignition temperature as tested in accordance with BS 738 (clause 16) is greater than 250° C.
Permali Limited, Bristol Road, Gloucester.

Miniature Thermocouple Leads

Additions are announced to the range of Philips Thermocoax miniature thermocouple wire distributed in the UK by Research and Control Instruments.

2BB Ac 10 consists of two wires of Alumel in a stainless steel sheath with an overall diameter of 1 mm. This material can be used—with two junctions of Chromel-Alumel—for measuring differential temperatures. Chromel-Alumel wires wires in a stainless steel sheath with overall diameters of 1·5 and 2·0 mm are called 2AB Ac15 and 2AB Ac 20 respectively. Yet another, 1Nc I 05 is a heating element of Nichrome in an Inconel sheath with 0·5 mm. overall diameter.

Philips Thermocoax wire has been designed for measuring a wide range of temperatures under extreme conditions such as surface and working temperatures of all kinds of heat treated materials, of furnaces, working machine parts, and heating and cooling installations.
Research and Control Instruments Limited, 207 King's Cross Road, London, WC1.

Plain Words

By Capricorn

As I passed two women in London last week one said to the other "I wish women's hats were as cheap as men's." What a depth and breadth of contemporary comment that remark evokes!

Women's hats could easily be as cheap as men's if only women would agree to some degree of standardisation of design. If they would accept, as men do, three or four basic types with only minor variations, the price would soon come down. For those daring women who at present wear outrageous hats, there would be extreme variations, as there are extra-curly bowlers for men. I do not think women would suffer by this standardisation, though I admit that much of the fun would be taken out of their hat-hunting expeditions.

There is an everlasting conflict today between exclusiveness, novelty, and uniqueness on one hand, and conformity, standardisation, and sometimes mediocrity, on the other. Yes, you can have your higher standard of living, but only on condition that you accept one of the designs that are thought to be suitable for you. We will go to immense pains to produce bright new designs every year, but if you don't like them you will have to go without. Even a man who can afford a Rolls-Royce wouldn't think of having a car specially designed for him from the engine to the finished coachwork. Everything now is beautifully designed to suit a mass market.

For anyone who feels like turning the world upside down, this atmosphere of too, too perfect end-products is rather enervating. And there are plenty of students about who feel like turning the world upside down. I visited the Young Contemporaries Exhibition in London last week. There are over three hundred paintings, nearly all of them in modern idioms, and there is a sizeable collection of sculpture. I felt that I would conform with the rebellious mood of the Young Contemporaries if I ignored all their paintings—however difficult it is to ignore them—and concentrated on the sculpture. To an engineer some of the sculpture is likely to be very disturbing.

One piece in particular bore a strong resemblance to a fabricated stay or stretcher such as you might see in many mechanical engineering workshops. When I looked closely at it I saw that the artist had been rather free with his design—and even freer with his welding.

Another artist—I think he must be rather a wag—had taken the copper ball from a cistern, attached various wheels and bits and pieces taken from a cheap alarm clock, added a pair of spectacles and produced a thing that looked like a parady of an artificial satellite but which he called "Billyballcock." Perhaps he was getting at his friends in the engineering faculty. More likely he was just blowing off steam because he finds the contemporary world a bit too smug.

Letters to the Editor

Measuring Surface Roughness

SIR,—Under the title "Orderly Progress in Surface Measurement" Mr. R. E. Reason wrote an article in your issue of 12 February (p. 230) which was a counter-argument to my article "Confusion in Measuring Surface Roughness" (ENGNG., 23 Oct. '59, p. 393). May I reply to some of the points he raised and also review briefly the present position in this practical engineering technique?

The Centre Line Average (CLA) method of surface measurement, as laid down in British Standard 1134, is adequate for many, but not all, types of surface. In some important cases it can be very misleading. On the Continent, particularly in Germany where a new approach was made about ten years ago utilising our experience, great progress has been made in developing other standards of surface measurement. The purpose of my article and of this letter is to stimulate interest and development work in Britain.

Mr. Reason says it is a sufficient specification of the nature of a surface to give (1) the CLA value, and (2) the process by which the surface was produced (e.g. grinding). In fact, this method of specification can sometimes suggest that two significantly different surfaces are the same. Such discrepancies are particularly likely to arise with turned or shaped surfaces.

In my experience, there is no one method of measurement which sufficiently specifies all surfaces. If, however, "G" is specified as well as CLA, a truer indication of the surface is given. G is the German *Glattungstiefe* ("depth of smoothness") and is an indication of the shape of the crests, whereas CLA is an indication of the arithmetical average depth. Clearly, G is more descriptive than CLA when considering the frictional characteristics of a surface.

The most effective way of specifying or measuring a surface is to use both G and CLA and then give the ratio G/CLA. A typical result of this method of surface measurement is illustrated by the Figure. It shows two surface measurement records of the same surface before and after lapping. The specimen was first turned in a lathe; the upper record shows the nature of the surface at that stage. Then without moving the specimen the surface was lapped and the second (lower) record taken. It will be seen that the surface was changed significantly: the sharp crests were removed or rounded. Obviously, this change in the surface altered the frictional characteristics appreciably, yet the CLA value decreased by only 9 per cent. The G value, however, showed a drop of 32 per cent. The ratio G/CLA was 2·27/1 before lapping and 1·69/1 after (420/185 and 285/168). Most machined surfaces come within the range 1·4 to 2·7.

Surface roughness records of the same surface before and after lapping, showing the removal or rounding of the crests (magnification: horizontal, 100; vertical, 1,000).

This example shows that if CLA is used alone, it can be misleading when a machining or finishing operation is superimposed on a previous operation—a common practice in engineering.

In Fig. 3 of Mr. Reason's article he added a third profile (*c*) to the profiles (*a*) and (*b*) quoted in my article, and stated rightly that (*c*) has the same G value as (*a*), implying that in this particular case G is nearly as useless as CLA. I am, however, grateful to Mr. Reason for adding profile (*c*) since it is evidence of the immense value of the ratio G/CLA. The ratio is 2·9 for (*a*), 1·1 for (*b*), and 1·5 for (*c*). These comparative figures agree very well with the obvious characteristics of the surfaces shown in his Fig. 3: (*a*) is the roughest, (*b*) is the smoothest, and (*c*) is intermediate.

Mr. Reason is, of course, correct in suggesting that Britain and the United States pioneered the development of direct-reading surface-measurement instruments, and Mr. Reason has perhaps contributed more to this development than anyone else. CLA still gives a valid indication of certain kinds of surfaces, particularly grinding, because this operation produces a surface in which the ratio of the pitch of surface irregularities to their depth is fairly uniform. But it is an over-simplification of a very complex problem to suggest that CLA, in conjunction with a specified finishing operation, gives the right answers for all kinds of surface.

Finally, I would like to refer to a comparison which Mr. Reason makes. He suggests that with better instrumentation, surface measurement will become as straightforward as hardness measurement. But we accept the need for several methods of hardness measurement; the same should be the case for surface measurement.

To ignore the results of extensive research on the Continent in recent years, while in Britain no major development has been reported, can hardly be called "orderly progress."

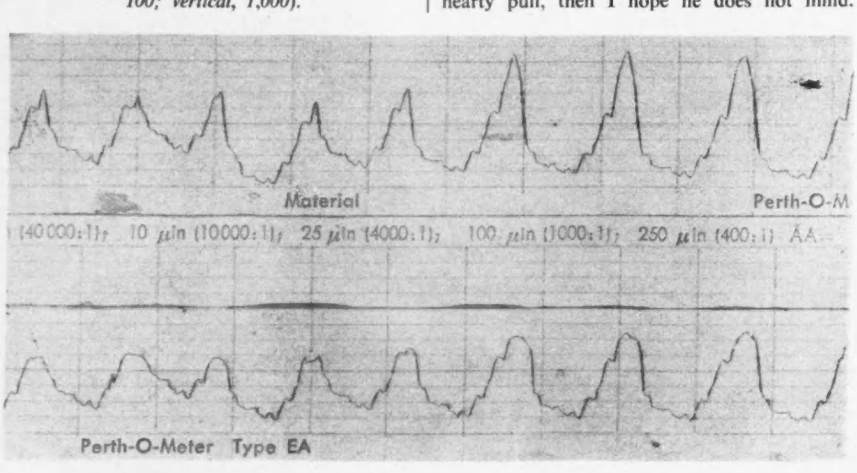
Yours truly,

M. P. RUBERT.

Rubert and Company Limited,
Acru Works,
Cheadle, Cheshire.

Concrete Strengths

SIR, Following my recent letter (ENGNG., 5 Feb. '60, p. 184), I should like to refer again to the maturity relationship for concrete, put forward by Dr. J. M. Plowman and my quibble on his use of the word "law" to describe that relationship. If I quote John Austin and by so doing manage to give Dr. Plowman's leg a good hearty pull, then I hope he does not mind.



Dr. Plowman and I understand and respect each other.

The entry of Mr. R. Narayanan, with dictionary under his arm (ENGNG., 4 Mar. '60, p. 313), takes us by one step into the lexicographical problem of meaning. I never did believe that the meaning of a word was solely the most convenient definition obtainable from a dictionary, nor do I believe that it descends from heaven in a blaze of glory and intuition. Meaning is built up solely upon years of experience so it is not surprising that definitions of law have exercised greater minds than mine since before Justinian.

Mr. Narayanan suggests that Plowman's relationship is part of that facet of law which is concerned with the uniformities of nature. But the laws of nature were considered as a command imposed by the Diety upon nature; I should hardly have thought that Mr. Narayanan would claim such inspiration for Plowman's "law!"

Yours faithfully,
T. N. W. AKROYD.

Constructional Services Limited,
123 Victoria Street,
London, SW1.
14 March, 1960.

Exhaust Fumes

SIR, Your article on "Limiting the Exhaust Fumes from Cars" (ENGNG., 19 Feb. '60, p. 252) is very interesting but I wonder how much notice has been taken of it. I wrote to Lord Hailsham on the subject of reducing the hydrocarbons and aldehydes some two years ago and I was told that the Government and the British motor manufacturers were jointly considering means of reducing these harmful substances. These two can produce lung cancer, but so far I have not seen any British manufacturer offering a unit to be fitted to any car, nor have I heard of any standard unit to fit to any car, for burning the exhaust gases with a view to eliminating polynuclear hydrocarbons and aldehydes.

I see, however, from your article that General Motors of America have produced a catalytic burner; surely it is more necessary in this country, which is so much smaller than America, that such a catalytic burner or other form of purifier should be introduced. Perhaps more publicity and more emphasis on the dangers of lung cancer caused by exhaust gases would help to put some life into the demand either by the public or the Medical Association for atmospheric purification.

Yours faithfully,
A. H. MCQUEEN.

13 The Dell,
Westbury-on-Trym,
Bristol 9.
18 March, 1960.

Charles Cooper

SIR, While his personality is so freshly in mind, perhaps I may add a few notes to the memoir of Charles Cooper (ENGNG., 4 Mar. '60, p. 318); for, during the ten years in which we shared the Editors' Room, a period which included the whole of the Second World War, I had exceptional opportunities to appreciate his many qualities. Our mutual understanding had to be developed quickly because, though working in the same building, we had previously been on different floors and engaged in very different fields, so that we had met but seldom; but it did develop quickly, and never did anything occur to shake it.

Perhaps the most remarkable thing about him was the constant up-to-dateness of his knowledge; the result not only of contacts with engineers and scientists of diverse interests, but of his innate urge to get to the bottom of things. He would never pass anything for publication until satisfied that he understood it, and if, in conversation or when reading some technical article, he encountered something that was unfamiliar, he would not rest until he had a clear picture of it in his mind. Thus it was that when Professor Frederick Soddy, F.R.S., in 1947, having failed in that difficult period to find a publisher for his book, *The Story of Atomic Energy*, approached us with the suggestion that it might be printed serially in ENGINEERING, Cooper was already equipped for the task of preparing Soddy's MS for press—no light undertaking even if he had been directly concerned with atomic research; and it was then a full 50 years since he had joined the staff. It is not given to many men to retain such a freshness and vigour of mind into late middle age.

To hear Cooper talk of his early days with ENGINEERING was to receive an insight into a vanished mode of life. The then Editor, W. H. Maw, he would recall, used to drive daily to the office from his home in Kensington in a pair-horse carriage, which returned for him in the evening; evidently there were no parking problems in Bedford Street in those days. The principal proprietors of the paper, Maw, James Dredge and A. T. Hollingsworth, had formed the business into a private limited company some six years before Cooper was engaged, but there were still men on the staff, in addition to these three, who could remember its modest beginnings and relate anecdotes of the erratic, irascible, but technically most capable American engineer, Zerah Colburn, who had founded it in 1866. The office lighting was by gas; the heating, by a Perkins high-pressure boiler; inter-communication, by speaking tubes; and, of course, every letter and character in the paper was set by hand.

As your memoir stated, Cooper's especial forte was detailed and accurate description. I can think of no better example than his report, in March, 1945, on the collection of scientific instruments and early scientific books which the late R. S. Whipple presented to the University of Cambridge. He showed this ability immediately he was transferred to editorial work, in 1919, when he wrote a series of articles describing the succession of British rigid airships. He was probably the only member of the staff to have flown in one—I think, in R38. It also fell to him to describe the Vickers Vimy bomber (relatively an easy task, as he had had so much to do with its development) and to record, in the issue of 20 June, 1919, the historic flight of Alcock and Brown across the Atlantic in one of these machines. In commenting on that flight, however, his judgment was for once at fault. "We do not share the view," he wrote, "that the Atlantic flight by aeroplanes will soon become a daily occurrence . . . lighter-than-air craft, as represented by large rigid airships, are more suitable for long journeys over the sea." In that opinion, of course, he was not alone at the time. He did not hold it for long.

Between the wars Cooper initiated and carried through a major change in practice in the preparation of line illustrations for ENGINEERING, materially improving their quality and also reducing their cost. The capabilities of his method were never better shown than by the two-page plate in the issue of 2 July, 1937, a longitudinal section of the 4-6-2 "Coronation" locomotive of the London Midland and Scottish Railway. At the Engineering and Marine Exhibition at Olympia, later in that year, Messrs. B. J. Hall Limited showed on their stand of photoprinting apparatus a reproduction of this plate, photographically enlarged to some 10 ft long or more. It withstood even that severe test, to Cooper's justifiable pride.

Though, throughout his ten years as Joint Editor and down to his retirement, he never wrote a leading article or, so far as I can recall, even suggested a subject for one, that is not to say that he ignored them. He read them in proof with the most scrupulous care, and his criticisms were penetrating; helpfully astringent as a rule, for he was a Puritan in the choice of words, though far from being a pedant. Carelessness in their use, and in every other respect, he abhorred, and that applied whether the offending statement occurred in an article of moment or in the merest paragraph. In such circumstances his comments could be blistering—sometimes, let it be admitted, disproportionately so; that, however, was really a pathological symptom. He was much troubled by insomnia and for 25 years or more had been unable to sleep without the aid of drugs. The particular soporific on which he had relied, on medical advice, before the Second World War was imported from Germany, and not for a long time was he able to obtain a satisfactory substitute; to a close observer, indeed, it seemed doubtful whether he did. It was a handicap of which few were aware, but it was very real.

Cooper seldom travelled abroad, and when he did it was usually to Switzerland, where he had many friends. At the beginning of our association, he insisted that Switzerland was to be regarded as his preserve—"You," he added magnanimously, "can have the rest of the world!" He did once report an International Railway Congress in Spain and, hopefully, learned Spanish in case another such opportunity occurred, which it never did; but he kept up his Spanish well enough to be able to read it at sight, and he had a fair reading acquaintance with technical French and German.

As a young man he became interested in astronomy, an interest that was encouraged by Dr. Maw, a former President of the Royal Astronomical Society, and by Cyril Young, Manager of Sir Howard Grubb, Parsons and Company, several of whose observatory instruments Cooper described in ENGINEERING. He had hoped to devote more time to astronomy in his retirement, but reckoned without the ill health that troubled his latter years. Quite late in life, he took up billiards; not very effectively, but with much contentment, philosophically reflecting that the poor player who brings off an occasional good shot possibly gets more pleasure out of the game than the expert who never misses. Still later, he developed an interest in the history of technology which led him to join the Newcomen Society, but again his health condemned him to a passive role. None of these pursuits, however, perhaps not even his astronomy, counted for very much in his scheme of things. His work was his life, and his chief enjoyment; especially the realisation that he was contributing something permanent to the store of recorded knowledge.

Yours faithfully,
J. FOSTER PETREE.

36 Mayfield Road,
Sutton, Surrey.
14 March, 1960.

Driving Tests

SIR, May I refer to the letter on driving tests written by Mr. Wallace Matthew (ENGNG., 4 Mar. '60, p. 313)?

I am quite unable to trace the alleged motoring correspondent he mentions, and have a feeling that he's got his facts mixed up. We have stated on many occasions that no test has ever or will ever be devised which will guarantee the subsequent conduct of the candidate. We do, however, have the last word in this matter, because any member whose conduct, subsequent to passing the test, is inconsistent with our aims and objects, is either suspended or expelled, and to date, 32 members have been dealt with in this way.

Yours sincerely,
GEORGE EYLES,
Director of Tests.

The Institute of Advanced Motorists,
21 Harrington Road,
South Kensington,
London, SW7.
9 March, 1960.

Efficient Use of Fuel

Arrangements have been made to hold a series of technical sessions in connection with the forthcoming Fuel Efficiency and Power for Industry Exhibition at Olympia. They will take place in the conference hall at Olympia on the afternoons of Monday and Tuesday, 2 and 3 May, commencing at 2.15 p.m., and the general theme of the papers to be read will be "The Selection of Fuel-Using Equipment and Power Plant."

In all, some 16 organisations, including such diverse bodies as the United Kingdom Atomic Energy Authority, the British Industrial Measuring and Control Apparatus Manufacturers' Association, the Institution of Mechanical Engineers, the Society of British Gas Industries and the Ministry of Power, are represented on the organising committee set up by the Institute of Fuel to supervise the meetings.

Five papers will be discussed, namely, "Effective Combustion in Steam Boilers," by D. C. Gunn; "Effective Use of Electricity in Industry," by W. J. Dickie; "Heat Transfer," by R. F. Hayman; "Heat Losses," by J. H. G. Bilney; and "Heat Recovery," by F. H. Newman. Advance copies of these papers will be available on application to the secretary, the Institute of Fuel, 18 Devonshire Street, London, W1, at a nominal charge of 9*d* to cover packing and postage. The meetings will be open to the public without charge.

Exhibitions and Conferences

Electrical Engineers Exhibition, Ninth.—Tues., 5 April, to Sat., 9 April, at Earl's Court, London, SW5. Sponsored by the Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (Tel. LANgham 5927); and organised by Electrical Engineers (ASEE) Exhibition Ltd., 6 Museum House, 25 Museum Street, London, WC1. Tel. MUSeum 3450.

South Eastern Union of Scientific Societies, 65th Annual Congress.—Fri., 22 April, to Mon., 25 April, at Ipswich. Apply to Mr. Frank Edwards, 53 The Drive, Shoreham-by-Sea, Sussex.

Production Exhibition, Fourth (International Exhibition of Progress in Industrial Technique).—Mon., 25 April, to Sat., 30 April, at Olympia, London, W14. Exhibition offices: 11 Manchester Square, London, W1. Tel. HUNter 1951.

Institute of Metal Finishing, Annual Spring Conference.—Tues., 26 April, to Sat., 30 April, at the Grand Hotel, Scarborough. Offices of the Institute: 32 Great Ormond Street, London, WC1.

Fuel Efficiency and Power for Industry Exhibition.—Wed., 27 April, to Fri., 6 May, at Olympia, London, W14. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester 3. Tel. Deansgate 6363.

Paper, Printing and Graphic Arts Industries, Sixth International Exhibition (TPG 60).—Fri., 29 April, to Sun, 8 May, at the Centre National des Industries et des Techniques (CNIT) in Paris. Exhibition offices: 40 Rue du Colisée, Paris 8.

Molecular Structure and Spectroscopy, Symposium.—Mon., 13 June, to Fri., 17 June, at the Department of Physics and Astronomy, Ohio State University. Apply to Professor R. A. Oetjen, Department of Physics and Astronomy, Ohio State University, Columbus 10, Ohio, USA.

Heat Treatment Practice, Conference.—Tues. and Wed., 5 and 6 July, at Harrogate. Organised by the British Iron and Steel Research Association. Apply to the technical secretary, Metallurgy (General) Division, BISRA, 11 Park Lane, London, W1. Tel. GROsvenor 4751.

Operational Research Societies, International Federation of: Second International Conference.—Mon., 5 Sept., to Fri., 9 Sept., at Aix-en-Provence, France. Organised by the Société Française de Recherche Opérationnelle, 27 Rue Lafitte, Paris 9e. Apply to the Operational Research Society, 64 Cannon Street, London, EC4. Tel. CITy 1800.

Brno International Trade Fair, Second.—Sun., 11 Sept., to Sun., 25 Sept., at Brno, Czechoslovakia. Organised by the Chamber of Commerce of Czechoslovakia, 8 Václavské náměstí, Prague, Czechoslovakia. Agents: Fairs and Exhibitions, Ltd., 2 Duraven Street, London, W1. Tel. HYDe Park 5421.

Men's and Boys' Wear Exhibition and Style Parade.—Mon., 26 Sept., to Thurs., 29 Sept., at New Cavendish Hall, Harrogate. Organised by the National Association of Outfitters, 21 Cavendish Place, Cavendish Square, London, W1. Tel. LANgham 2918.

Corrosion Exhibition.—Tues., 29 Nov., to Fri., 2 Dec., at Olympia, London, W14. Organised by *Corrosion Technology*, Leonard Hill House, Eden Street, London, NW1. Tel. EUSton 5911.

Metallic Corrosion, First International Congress on.—Mon., 10 April, to Sat., 15 April, 1961, in the Imperial College of Science and Technology, South Kensington, London, SW7. Apply to Lieut.-Col. F. J. Griffin, hon. secretary of the congress, at 14 Belgrave Square, London, SW1. Tel. BELgravia 3681.

Sydney International Trade Fair.—Tues., 1 Aug., to Sat., 12 Aug., 1961, at the Royal Agricultural Society's showground, Sydney, Australia. British participation is being organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Silicon Photo-Voltaic Cells for Instrumentation and Control Applications," by Drs. V. Magee and A. A. Shepherd. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 30 Mar., 6.30 p.m.*

Institute of Fuel

CARDIFF
"The Benson Boiler": four papers by staff of the Steel Co. of Wales Ltd. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 1 April, 6 p.m.

Institute of Marine Engineers and Royal Institution of Naval Architects

SOUTHAMPTON
"Marine Machinery Failures," by H. N. Pemberton. Annual General Meeting. Southern Joint Branch. Southampton Technical College, Southampton. Tues., 29th Mar., 7.30 p.m.

Institute of Marine Engineers

LEEDS
"Holmes-Werkspoor Engine: Building, Testing and in Service," by Bryan Taylor. Kingston-upon-Hull and East Midlands Section. Great Northern Hotel, Leeds. Thurs., 31 Mar., 7.30 p.m.

Institution of Civil Engineers

LONDON
"Parking." Traffic Engineering Study Group Discussion, introduced by R. Nicholas. Tues., 29 Mar., 5.30 p.m.*

Institution of Civil Engineers of Ireland

DUBLIN
"Engineering Library Resources," by J. G. Daly. Mon., 4 April, 6.15 p.m.*

Institution of Electrical Engineers

LONDON
"Place of Illumination in Electrical Engineering." Discussion opened by G. F. Freeman. Education Discussion Circle. Tues., 29 Mar., 6 p.m.
"Cosmic Radiation," by Professor C. F. Powell. 51st Kelvin Lecture. Thurs., 31 Mar., 5.30 p.m.*
BRISTOL
"Factories Act: Electricity Regulations," by S. J. Emerson. Western Utilisation Group. South Wales Electricity Board's offices, Colston Avenue, Bristol. Mon., 28 Mar., 6 p.m.*
EASTBOURNE
"Provision of Adequate Electrical Installations in Buildings": (*a*) "Commercial Buildings," by E. E. Jacobi, and (*b*) "Small Industrial Premises," by J. A. Sharp. Southern Centre. Burlington Hotel, Eastbourne. Wed., 30 Mar., 7 p.m.
HULL
"Recent Developments in Colour Television," by I. J. P. James. North Midland Centre. Yorkshire Electricity Board's offices, Ferensway, Hull. Thurs., 31 Mar., 6.30 p.m.*
LEEDS
"Teaching of Servo-Mechanisms," by Dr. P. H. Walker. North Midland Centre. Electrical Engineering Department, The University, Leeds. Tues., 29 Mar., 6.30 p.m.*
LIVERPOOL
"Dangerous Electric Currents or Quantitative Effects of Electric Shock on Man," by Professor Charles F. Dalziel. Annual General Meeting. Mersey and North Wales Centre. Donnan Laboratories, Vine Street, Liverpool. Mon., 28 Mar., 6.30 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"Engineering and Layout of Chemical Plant," by R. B. T. Hall-Craggs. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Fri., 4 April, 7.45 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Design of Ship's Interiors," by Professor M. Black and K. Bayes. Tues., 29 Mar., 6.30 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
"Heated Acoustic Ceilings": Discussion. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 29 Mar., 7 p.m.

Institution of Highway Engineers

LONDON
"Modernisation of London-to-Brighton Trunk Road A23" (with film), by L. G. Williams. Institution of Structural Engineers, 11 Upper Belgrave Street, SW1. Fri., 1 April, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"The Need for Post-Graduate Refresher Courses for Engineers in Industry." Education Group. Discussion. Tues., 29 Mar., 6 p.m.*
"By-Pass versus Full-Flow Filtration." Lubrication Group. Discussion. Wed., 30 Mar., 6 p.m.*
LINCOLN
"Altitude Testing of Aero-Engines," by Group Captain G. E. Watt. East Midlands Branch. Technical College, Lincoln Wed., 30 Mar., 7.15 p.m.
SLOUGH
"Performance of Vehicles under Trans-Antarctic Conditions," by D. L. Pratt. Annual General Meeting. Eastern Branch. Good Companions' Hotel, Stoke Poges Lane, Slough. Thurs., 31 Mar., 7.30 p.m.

Institution of Plant Engineers

DURHAM
"Type and Application of Plant for Opencast Coal Extraction," by H. Briggs. North East Branch. Three Tuns Hotel, Durham City. Thurs., 31 Mar., 7 p.m.
SHEFFIELD
"Work of the City Engineer's Department," by J. E. Kirkham. Sheffield Branch. Grand Hotel, Sheffield. Thurs., 31 Mar., 7.30 p.m.

Institution of Production Engineers

MANCHESTER
"Economics of Machine Tool Purchase," by J. Borsay. Annual General Meeting. Manchester Section. Manchester College of Science and Technology, Sackville Street, Manchester. Mon., 28 Mar., 6.30 p.m.
READING
"Production Depends on Communication," by A. C. Leyton. Annual General Meeting. Reading Section. George Hotel, Reading. Thurs., 31 Mar., 7 p.m.

Newcomen Society

LONDON
"Some Windmill Fallacies," by Rex Wailes. Wed., 6 April, 5.30 p.m.

Royal Aeronautical Society

COVENTRY
"Optimum Size of Rocket Engines," by J. E. P. Dunning. Coventry Branch. Herbert Art Gallery and Museum, Jordan Well, Coventry. Thurs., 7 April, 7.30 p.m.

Royal Society

LONDON
"Science in the Ceramic Industry," by Dr. N. F. Astbury. Thurs., 31 Mar., 4.30 p.m.*

Royal Society of Arts

LONDON
"Problems, Future Developments and Prospects of the Internal System of Transport," by D. L. Munby. Wed., 30 Mar., 2.30 p.m.

Royal Statistical Society

SHEFFIELD
"Bayesian Statistics," by D. V. Lindley. Sheffield Group. Grand Hotel, Sheffield 1. Thurs., 31 Mar., 7 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Corrosion: The £600 Million Problem," by A. M. Edwards. BISRA Laboratories, Hoyle Street, Sheffield 3. Tues., 29 Mar., 7 p.m.

Society of Engineers

LONDON
"Research Testing," by A. E. Bingham. Geological Society, Burlington House, Piccadilly, W1. Mon., 4 April, 5.30 p.m.*

Society of Instrument Technology

LONDON
"Application of Transistors in Instrumentation," by G. G. Bloodworth. Manson House, 26 Portland Place, W1. Tues., 29 Mar., 7 p.m.*
CARDIFF
"Electro-Magnetic Flow Meters," by L. M. Bennett. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 30 Mar., 6.45 p.m.
CHESTER
"Education and Training of Instrument Personnel," by E. B. Jones. Chester Section. English Speaking Union's offices, Stanley Palace, Watergate Street, Chester. Thurs., 31 Mar., 7 p.m.
FAWLEY
Annual General Meeting and Film Evening. Fawley Section. Administration Building, Esso Refinery, Fawley. Fri., 1 April, 5.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Civil Engineers of Ireland, 35 Dawson Street, Dublin.
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

Austrian Industry Looks East and West

One of Europe's smallest countries, Austria is well provided with natural resources. If trade between West and East Europe makes rapid growth Austria is well placed to benefit.

By Richard Bailey

Of the Outer Seven, Austria is the country with the closest links with the Common Market. Over 54 per cent of her imports come from, and about half of her exports go to, the Six. The logical thing from the economic point of view would seem to be for Austria to have joined the Common Market. But economic considerations are not the only ones. There is the legal problem of neutrality which might arise if Austria joined the Six. Even stronger is the desire of the Austrians to keep control of their own economy and to be free to trade wherever they wish, which includes trading with their eastern neighbours. The Austrians saw in the European Free Trade Association the best way of overcoming the deadlock following the failure of the earlier Free Trade Area negotiations. What sort of products will Austrian industry bring into the new trading group?

In general it is probably true to say that the Austrian economy is the most diversified among the Seven, except for that of Britain. And the Austrians believe that several industries will have a good chance in the wider market. Those most likely to benefit are iron and steel, some branches of metal working and engineering, scientific instruments, aluminium, textiles, clothing and semi-processed chemicals. Not all the advantages will be in one direction. Some British products will probably be imported in greater quantities. One of the big differences which the visitor notices between the Viennese and the Munich or Frankfurt street scene is the much greater number of British cars passing by.

ELECTRICAL INDUSTRY

Among the Austrian firms that hope to do well out of freer trade are those in the electrical machinery and appliances industry. Over 47,000 workers, about 8 per cent of the working population, are employed in the 190 firms in this industry. The products range from heavy machinery, transformers and switchgear, through household appliances, wire, cables, measuring instruments and meters to batteries, bulbs and neon tubes. There is also an expanding telephone, radio and television industry. The biggest handicap under which the electrical industry works is the relatively small size of the firms. Only one concern has over 5,000 workers, and only 11 have between 1,000 and 5 000. This means that the possibilities for research are very restricted. Many Austrian science and technology graduates move north to the research laboratories of factories at Stuttgart, Munich and elsewhere because of the lack of opportunities to acquire specialised knowledge at home.

This is one reason why, although Austrian production of electrical goods of all types has been steadily rising in the last few years, productivity has increased only slowly. If foreign competition is to be met parts of the industry will undoubtedly have to become more efficient. But the Austrians are by no means depressed about their chances of holding their own. Demand for electrical machinery and appliances both for the home market and for export is going to be very great. To take just a few examples, there is the programme of electrification for the railways of which at present about half has been carried out. Further hydro-electric schemes needing turbines and other installations are planned to meet increasing electric power demands. And at the other end of the scale television is just beginning to take on in Austrian homes.

In order to rise to its opportunities the electrical industry will have to bring itself up to date. Mergers between some of the bigger concerns are being discussed. One in particular that is widely talked of is that between ELIN (Aktiengesellschaft für-elektrische Industrie), and the AEG Union Elektrizitäts-Gesellschaft, both of Vienna. One difficulty is shortage of capital and this will probably be increasingly made good by foreign investors and loans to particular firms from abroad. The products of the electrical industry which are best able to compete with those of firms in the Common Market and Outer Seven are generating equipment and big transformers. For smaller items future prospects depend on how quickly Austrian firms can organise mass production lines.

MOTOR INDUSTRY

The scale of the motor car industry in Austria is limited by the small home market. The biggest company, Steyr-Daimler-Puch AG, employs about 16,000 workers. It manufactures lorries and a small car in conjunction with Fiat. The result of this collaboration is the Steyr-Fiat which is essentially the Fiat 500 with an Austrian made engine. The motor is of the same capacity as those made in Italy but of a different type. The performance of the two cars—Austrian and Italian—is said to be practically identical. Another group, Denzel, produces a sports car version of the Volkswagen.

About half the Steyr-Daimler-Puch output is exported. Of this, 27 per cent went to the Common Market and 41 per cent to the members of the EFTA, notably Switzerland. But with the giant motor firms of the Six and of Britain making a drive for sales in the Austrian market the prospects of developing a strong local industry are not good. Of the European cars, the Fiat, Volkswagen and Opel are most frequently seen on Austrian roads, but more Dauphines have been coming in over the past six months. All the big British firms have selling and service arrangements in Austria and sales are rising. The German makers have a considerable lead however, and it is doubtful whether the tariff advantage which Britain will eventually have in the Austrian market will make much difference to this.

IRON AND STEEL

The Austrian iron and steel industry has been faced with the problem of the big European Common Market ever since 1953, when the ECSC started to remove restrictions on trade in coal and steel. The last remaining duties on iron and steel within the six member countries were removed in February of 1958. Since then outside countries, such as Austria, have been faced with tariffs on their products entering Germany and other countries which have not applied to the Community countries. This fact has affected the attitude of the Austrian iron and steel industry to the question of freer European trade. There are now no duties on iron and steel products within the ECSC, whereas in the broader European Economic Community duties on other manufactured goods will not be entirely eliminated for 12 or 15 years. The Austrian steel makers have pressed for the immediate reduction of steel tariffs as soon as the European Free Trade Association came into being. To do this would, of course, involve questions of origin, uniform pricing policies within the EFTA and anti-dumping legislation. It is important for the Austrian producers that they should be closely allied with the Common Market. In 1957 about 47 per cent of Austrian rolled steel products were exported, and about half of these went to the Six, and two-thirds to the OEEC area as a whole. In the same year iron and steel products accounted for 19 per cent of all Austrian exports. The difficulties of trading with a Common Market in which the tariff barriers are down is illustrated by what happened in the case of Italy. In 1957, Austrian iron and steel exports to Italy totalled 1,053 million schillings. In the first half of 1958 this fell to a bare 314 million schillings. Iron and steel is one Austrian industry that will find it very difficult to divert its exports away from the Common Market. Consequently, it is likely to find life increasingly difficult as integration within the ECSC proceeds. Even so VOEST and other Austrian steel makers are turning out nearly twice as much as before the War. The problem is whether this expansion can be maintained.

Other basic industries in Austria also show a considerable increase on pre-war years. Today Austria produces about half of the world production of 2·2 million tons of magnesite. Aluminium, of which Austria produced only some 4,400 tons in 1937 has now soared to an output of 72,000 tons a year. This level of production is likely to be maintained. One industry that is able to face the future with calm assurance is the electric power industry. Austria exports considerable quantities of electricity over the European power grid. It is now nearly 30 years since the Vorarlberger Illwerke AG began delivering power to the Rhine-Westphalia industrial area of Germany. The Austrian power lines are today connected up to those of all its Western neighbours. The country is, in fact, the leading European exporter of electric power with nearly 2,000 million kWh a year.

FACING THE FUTURE

Bearing in mind that Austria had to start from scratch in 1945 and that the Russian occupation lasted ten years after that, a great deal has been achieved. Even so it would be a mistake to imagine that expansion on the same scale as in Western Germany is likely there. A great deal of plant was dismantled during the occupation and much of what is left is now obsolete. United States aid received under the Marshall Plan—$1,000 million—made possible a considerable overhaul of the economy.

One factor that must be taken into account in assessing the future prospects of the Austrian economy is that a number of important industries and institutions are nationalised. These include banking, mining, iron and steel, oil, aluminium, and a mixed bag of small concerns. The Government also holds the majority of shares in the hydro-electric power undertakings. On top of this the state-owned banks control a number of firms scattered throughout industry. All told it is probably true to say that state-ownership is more widespread in Austria than in any other ostensibly free-enterprise economy.

Apart from its industries Austria has two other attractions for the countries of the Common Market and EFTA alike. These are the tourist industry and its position as a European trading and exhibition centre. The Vienna Trade Fair has become one of the most important commercial gatherings in Europe. Engineering products are shown in the Prater Gardens in the shadow of the Giant Ferris Wheel.

Although today Austria is involved in the problems following the division of the West European countries into the Six and Seven, she is equally concerned over the split between east and west. For centuries Vienna was on one of Europe's cross roads. Now the roads to the east, like the Danube, lead away into satellite countries. There are many business men in Austria who hope that the old trading connections with the east will be re-established and that their country because of its situation in the heart of Europe may have a part to play in bringing together east and west as well as harmonising relationships between Six and Seven.

Wind Tunnel Tests and the Whole Car

Airflow affects many aspects of automobile performance. Increasing use is being made of wind tunnels for solving engine and car-frame problems in new designs.

Higher car speeds draw increasing attention to the influence of airflow on such things as engine and brake cooling, petrol consumption, and car stability. However, the design demands that airflow makes on these different aspects of a car tend to be conflicting. Very often, at speeds above 50 m.p.h., the air around a passenger car is absorbing at least half the engine power output. But attempts to reduce the drag to improve petrol consumption figures may lead to overheated engine, transmission, or brakes; or to a body shape that yaws alarmingly on hitting a side wind at speed. The task of producing an optimum solution to these conflicting requirements occurs during the design of every car.

Aerodynamic instability in cars had not been observed to any great extent in this country—until the M1 motorway came into operation. However, it has been known for some time that the development of a streamlined shape for a passenger car involves moving the lateral centre of pressure away from the centre of gravity, and that angled sidewinds flowing around the resulting aerofoil section could produce pronounced sideways forces, strong enough to sheer the vehicle wildly off course. Racing cars are fitted with vertical fins if their form of streamlining is likely to reduce lateral stability; it may be that similar attachments will be called for on normal passenger cars using motorways. Probably some of the single car smash-ups that have occurred on the M1 have been caused by a combination of aerodynamic side forces (which can reach 10 per cent of the vehicle weight), wet road surface, and a driver's unfamiliarity with such conditions.

AERODYNAMIC SHAPES

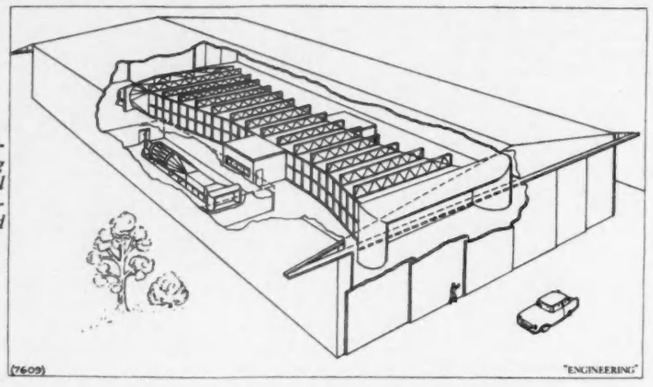
Other design problems relating to air flow include the flow of air to the engine induction system, which affects power or the possible entrainment of dust; the flow of air into the passenger compartment; possible extractor effects of air currents on the exhaust system; the impingement of mud, dust, or insects; and intensity of wind noise produced by the car body. In fact, the aerodynamic shape of a car can affect its safety, running economy, durability, and comfort.

These considerations have led to an increasing number of experiments on car design, in and out of wind tunnels. The " floating body " method has been used, whereby load measuring devices are inserted between the car body and its chassis. In this way the drag, lift, and side forces can theoretically be measured directly; in practice the experimental technique is very difficult. Another method is to mount the complete car on top of a railway truck or lorry and to measure the forces on the wheels as the car moves through the air. The Volkswagen, for example, was tested by mounting it on a special platform attached to the top of a single-decker bus, the platform serving to reduce the air disturbance generated by the bus. Side wind effects could be examined by mounting the car at an angle to the centre axis of the bus.

Other methods involve subtracting transmission and tyre losses from the total drag experienced by a vehicle to obtain the value of the aerodynamic drag. Techniques include towing a car on a long towline connected to a dynamometer in the towing vehicle, rolling a car down an inclined plane and measuring its velocity, measuring the torques in the car transmission system, and timing a car as it decelerates to rest on the flat with brakes and engine off. In such tests on the road the variability of weather conditions produces problems, and lift and side forces cannot be measured. As far as road tests in general are concerned, roads lined with forests and running in the direction of the prevailing wind are to be preferred.

Variability of conditions in the open air have led to the increasing use of wind tunnels for car design. The Bentley Continental, Renault Frégate, and Borgward Hansa 2400 are among cars developed in conjunction with wind tunnel tests. A wind tunnel has been installed at the Austin Motor Company factory, Longbridge; and two tunnels are being constructed at the Motor Industry Research Association (MIRA), Lindley, Warwickshire.

A German firm of radiator manufacturers have built a temperature controlled installation capable of taking full-sized vehicles, including motor coaches. Vehicle wheels rest on dynamometer brake drums and equivalent road speeds of up to 150 km per hour can be simulated. The tunnel has a cross section of 4·5 m by 4 m high and air temperatures can be varied from − 25° C to + 60° C.



The full-size and quarter-scale wind tunnels being built at MIRA will facilitate the investigation of air resistance and stability problems.

The Harrison Radiator Division of General Motors (USA) have a small area tunnel that directs a uniform flow of air at controlled speeds on to the car radiator. For such experiments, air temperatures can be increased up to 52° C.

The Ford Motor Company (USA) have been operating a 10 ft by 11 ft wind tunnel for some time. It produces air speeds of up to 80 m.p.h. and the temperature can be controlled from − 35° C to + 75° C. Recently, the company have built a larger tunnel.

Records of work done in Ford's first tunnel show that 60 per cent of the time was used for development of engine cooling systems, 15 per cent for heaters and defrosters, 12 per cent for air conditioners, and 13 per cent for other problems. In the last category were included investigations of body leakage and ventilation, carburettor icing, vapour lock and octane ratings, and acoustic and aerodynamic measurement. For some of these latter tests the correlation of tunnel data with road experiments has turned out to be rather poor.

HANDLING DATA

The company's new tunnel, designed after experience with the first, has a cross-section of 20 ft by 12·5 ft high, and although the main programme will again be concerned with engine cooling and similar work, the tunnel should prove more suitable than its predecessor for aerodynamic studies. A maximum continuous wind speed of 125 m.p.h. is available and refrigerating, heating, and humidifying plant are installed, together with equipment to simulate rain and sunshine. Associated data-logging equipment is capable of digitising the outputs of up to 60 transducers and has built-in circuits for simple mathematical operations such as multiplication (for horse-power derivation, for example). The digital nature of the output renders it suitable for rapid analysis by computer and is the technique used in modern aircraft wind tunnels, for example, at the Royal Aircraft Establishment, Farnborough.

Aerodynamic studies will play an important part in the programme of the MIRA wind tunnels. To find out the best type of installation for such work the association carried out exploratory tests on full-sized cars in the 24 ft wind tunnel at RAE and on scale models in the 5 ft by 4 ft wind tunnel of Sir W. G. Armstrong Whitworth (Aircraft) Limited, Coventry, and the 8 ft by 6 ft tunnel of the College of Aeronautics, Cranfield. Three full-sized cars and their corresponding models were used in these tests. In addition, a comparison was obtained of the drag coefficients of full-sized cars measured in the wind tunnel and on the open road. Road tests were limited to the measurement of drag, but wind tunnel tests investigated lift and side forces, and the rolling, yawing, and pitching moments as well—all quantities being measured both in relation to head wind and at different angles of yaw, to simulate cross-wind effects. From the tests it became clear that a model tunnel would be economically sound for testing in the early design stages of a vehicle, but a full-size tunnel would be essential in the final stages of prototype development.

A sketch of the proposed wind tunnel installation at MIRA is shown above. Both tunnels are of the open return type in which the air ejected at one end returns slowly to the entry section through the surrounding building. The large tunnel will have a flared entry leading to a section with parallel sides in which is set a straightener of honeycomb cross-section. This leads to a contracting section before entering on the working zone, which has parallel sides. The cross section of the working zone measures 26 ft by 14 ft 6 in high and it extends for a length of 50 ft. Let into the floor will be a balance for measuring the air loads on the vehicle under test and also a chassis dynamometer to absorb power from the wheels. Air speed will vary from 25 to 80 m.p.h. in eight fixed steps. From the working zone the air will be slowed down in a diffuser, before being withdrawn from the tunnel by four fans working in separate ducts.

The small tunnel is intended for models up to quarter full-size. It will have a working zone measuring 12·5 ft long, by 6·75 ft wide by 3·375 ft high; its general design will be similar to that of the full-size tunnel, and it will have the same range of airspeeds. The maximum speed will call for a power imput of 35 h.p.

In choosing a maximum speed of 80 m.p.h. for the model tunnel it was considered that on a quarter-scale model, being $\frac{1}{4}$th of the volume and having a frontal area $\frac{1}{16}$th that of the full-size version, the aerodynamic forces would be four times greater in relation to the model weight, so easing measurement of the forces.

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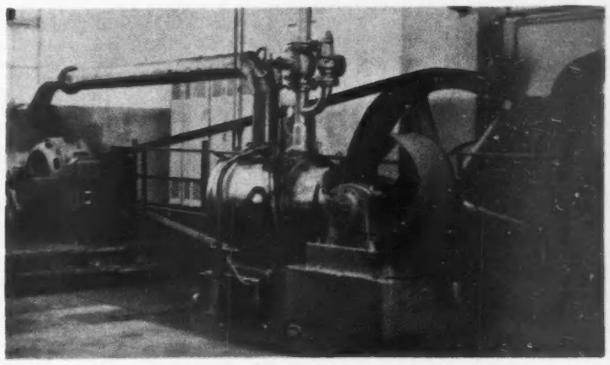

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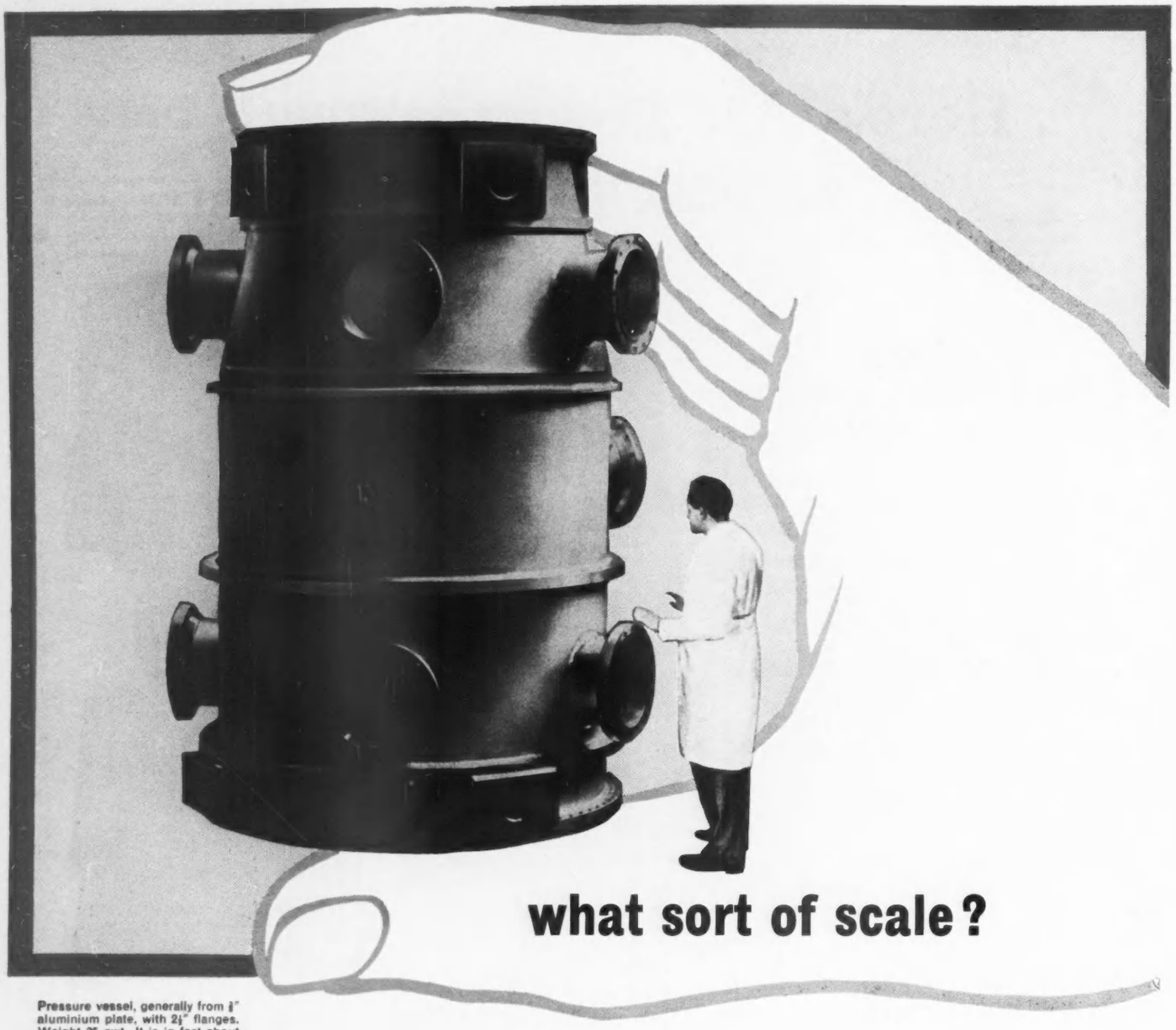

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Human Element

Staggered Hours By Order

Asking firms to stagger their working hours and so reduce peak city travel congestion has been going on for 15 years and has failed. Now business hours should be compulsorily staggered.

Mr. A. J. White, former assistant general manager of the Eastern Region, British Railways, proposed this hard-to-apply step to the Metropolitan section of the Institute of Transport. He pointed out that peak congestion was worse than ever at a time when expensive rolling stock for urban and suburban services was poorly utilised and frequently running at a loss.

What is so difficult to imagine is a way in which business hours could be compulsorily staggered without seriously impeding the business that the firms concerned exist to transact. Supposing that new penalties were introduced and a man from Office X was detected using Oxford Circus underground station at a time when employees of Office Y should have been making their uncrowded way home.

As a loyal employee he might very well say that only zeal to clear his IN tray caused him, quite voluntarily, to stay an extra 15 minutes.

It might be possible to get all the companies in a particular trade to go at set times—all the advertisers at 4.30, insurance offices 4.45, electrical engineering head offices at 5.00. But what happens at 4.55 when an electrical executive wants to make a vital change in an advertisement's detailed information?

Not surprisingly the brunt of London's transport inadequacy is borne by the employees and not by their offices. The housewife, too, suffers from staggered hours: a household with a growing child at school, and two older youngsters as well as father out at work could produce a succession of evening meals that would give mother no rest at all—and be very uneconomical of the household's budget.

A Friendly Hand to Commonwealth Students

One of the most vigorous bodies in London working to make Commonwealth students and other visitors at home in the capital is the Victoria League, which is 60 years old next year.

The league, like many other English institutions, owes its birth to reasons not evident from its title. During the bitter troubles in South Africa as the old century was giving place to the new a group of women known as the Guild of Loyal Women, successors in their way to Florence Nightingale, wrote letters protesting at the conditions of the refugees and the neglect of the battle casualties. The letters were written to some purpose for in April, 1901, a meeting was held at 10 Downing Street, and the Victoria League established.

Working towards its ideal of increasing friendship within the Commonwealth, the league has grown over the years to its present United Kingdom membership of just over 7,000. The Commonwealth membership is 34,000—Australia accounting for 15,000 of the total.

From the friendly and informal Victoria League House in Chesham Place, London, SW1, the League embraces a wide range of activities, providing a meeting place and an overseas students club and arranging accommodation, introductions to overseas leagues and contact with English families living near the lodgings in which Commonwealth students are staying during their period of study in this country.

Main Lines and Branches of Railway Thought

Until the Government's planning and reorganisation board for the railways has reported and its proposals acted upon, or not, the future shape and functions of the railways have a high place in public argument.

Mr. Sidney Greene, the National Union of Railwaymen's secretary, has recently called the idea, which has been actively urged in some possibly not-disinterested quarters, of hiving off the profitable side-interests of the Transport Commission, a "barmy idea."

Mr. Greene's suggestion that the railways should have their present restrictions lifted and be allowed to develop the land they own makes sense. It is not possible to see large tracts of the most valuable land in the country covered by dear-to-run rails in New York. Profitable office accommodation long ago went soaring up into the sky, and into the credit columns, above the stations.

A moment's thought on what could be done with office developments over the stations and track at Waterloo, Charing Cross, Paddington and the big provincial centres shows that here is a possible way to meet the costs of Guillebaud.

If these profitable developments were to fall into the hands of current well known property market speculators then it might be that justifiable public ill will would be generated.

Science in the New Nations

Energy and electronics will be on the agenda of next August's conference in Israel on the place of science in the progress of new nations.

The sponsors are the Weizmann Institute of Science.

One of the distinguishing features of educational attainment among the peoples of the states achieving independence has been a tendency for students to go for law, or perhaps medicine, leaving engineering and science strangely neglected. Now the new states in Africa and elsewhere are reputed to have strong feelings about their inability even to talk the same technical language as more developed nations.

Three of the subjects to be discussed in Israel are those that Western advisers might put rather higher in priority than would the representatives of the new states. They are agriculture, nutrition and health. There is something of a chicken and egg problem here for without more machinery and a measure of industrialisation substantial improvements in agricultural productivity and so nutrition and health may be difficult indeed to attain. Lack of health and the better nutrition to maintain it is a serious drag on the efforts of some of the former colonial territories to improve their material standards.

If the conference in Israel ultimately puts Ghanaian, Nigerian, Guinean and Asian scientists alongside those of America and Europe in struggling with the problems of nuclear physics and biology a solid step forward will have been made for both sides of the bargain.

Town Planning Medal for American

The Howard medal, awarded to those of outstanding contribution to the idea of new towns and garden cities, has been conferred on Mr. Clarence Stein, the American architect and town planner whose likeliest monument is the Radburn scheme in New Jersey, USA.

Mr. Stein was in the forefront of the establishment of the United States' four green belt towns.

The Howard medal commemorates Sir Ebenezer Howard, founder of the garden cities and new towns movement. The roll of those to whom it has been awarded includes Lewis Mumford, Sir Patrick Abercrombie and Sir Raymond Unwin.

The medal is to be presented by Lord Salter, president of the Town and Country Planning Association, at a lunch given for Mr. Stein at the Connaught Rooms, London, on Monday, 28 March, 1960. The annual general meeting of the Association follows the lunch and after the meeting Mr. Stein will address the members. The Association states that those who would like to attend the lunch are invited to do so. Tickets—30s.

Lord Birkett for ETU Inquiry?

The two top leaders of the Electrical Trades Union left their meeting with the Finance and General Purposes Committee of the Trades Union Congress wreathed in smiles. It was learned that the exchanges had been amicable.

None of this should obscure the fact that unless the TUC summons up its courage and at the same time does some rather more subtle thinking than usual it will not escape from the position into which the ETU leaders have manoeuvred it.

Once the ETU affair was lined up within the sights of the TUC's constitutional "firing squad"—Rule 13—it was plain that the union's leaders were not going to stop an inquiry simply by declaring that the allegations of ballot rigging and Communist Party influence had been countered by executive statements.

What now matters is the power, of evidence taking and witness calling, with which the inquiry is to be equipped. Even more important is the experience and training of the man to conduct the proceedings.

Mr. Frank Foulkes, the union's president, has suggested a distinguished union figure should take on the job. He mentions the name of Sir Richard Coppock, the revered building union's chief.

The spectacle of Mr. Foulkes virtuously baring his breast to a fellow trade union leader is one that may appeal to many rank and file trade unionists. It has an aura of respectability that may be difficult for the TUC to dispel.

But it may be that they have no practical choice but to put aside this skilful offer—for this reason. The venerable trade union figures whose names have cropped up do in fact have what Mr. Foulkes claims for them, a first hand acquaintance with the significance of trade union branch life. It is to be hoped that they do not all have first hand experience of the sort of malpractices alleged by Mr. Foulkes's critics.

But they do not have legal training. The last resort, the essential weapon of the lawyer, is the word by word study of evidence leading to the fatal flaw and the exposure of the opposition's secrets. The last ditch weapon of the trade union leader is still that blunderbuss the strike.

Is there a lawyer whose standing with the trade unions is so high that the inevitable protests from the ETU leaders would not prevail? One at least exists.

Hour by hour and week by week Lord Birkett struggled through the complexities of the printing strike last year, emerging with a settlement and with a towering reputation among trade union leaders and members.

The TUC could well call him in on this even more important dispute.

What Colour Carpet for Research Staff?

In industrial organisations where reward is often geared to the extent of administrative responsibility and the number of subordinates a man commands, how is the key research man working with perhaps one humble assistant to be given proper pay and status?

Lord Nelson of Stafford, chairman of the English Electric Company, examined this current problem earlier this month in his paper "Management of Research," read for him at the International Congress of Scientific Management, at Melbourne, Australia.

Research scientists entering industry sometimes find it difficult to understand why people of much lower educational attainments and apparently lower social status should enjoy greater privileges than themselves in the industrial hierarchy. These are Lord Nelson's words and they refer to a genuine situation.

The English Electric chairman saw the problem in two parts. First that the research scientist has not learnt the ways of industry and has to be taught that the salesman, the works superintendent and other non-technologists play a vital part even in a technical industry. The second problem described by Lord Nelson was that of the older and very successful research worker whose qualities demand that he should be kept on research work rather than be promoted to an administrative or executive post.

Lord Nelson thought something might be learned from the Services who have divorced rank from function. "Thus in the Army when a man attains the rank of Colonel, whether he be sitting in a desk at a foreign embassy, acting as a staff officer in a ministry, or commanding a battalion in the field he is entitled to the perquisites of his rank. This is a problem which many industrial concerns in Britain and America are considering and one which will require much careful thought in future."

The Structural Forms of Timber Roofs

A timber roof for a given area may be one of several types. Hardwoods allow higher stresses but cost more. Choice of fastening depends on the timber and structural form.

By L. G. Booth, M.A., Ph.D.

University of Southampton

The majority of timber structures in the United Kingdom are constructed with softwoods, very few hardwoods being used.

The softwoods are divided in the Code of Practice into two groups according to their strength.[1] In general, availability reduces Group I to one timber—Douglas fir—and Group II to two timbers—redwood and Western hemlock. When making the initial choice of the timber group to be used in a design the engineer should bear in mind the lengths and sizes available[2], and also the variation in cost. These factors are variable throughout the country and also vary according to the time of the year. Very roughly it can be said that redwood is available in thicknesses up to 4 in, widths up to 9 in and lengths up to 20 ft, whereas in the case of Douglas fir and Western hemlock widths up to 12 in and lengths up to 25 ft can normally be obtained. Larger sizes and lengths can always be obtained at greater cost. Group I timbers are 25 per cent stronger than Group II, but since they may be up to 40 per cent more costly, economy will only result with their use in specific designs.

The use of hardwoods may lead to economy when it is remembered that many of these timbers are between 1½ and 2 times as strong as Douglas fir, and since fewer knots are encountered the working stress of some hardwoods will be between 2 and 3 times greater than that of Douglas fir. Since hardwoods may cost up to 4 times as much as Douglas fir it will be seen that each design must be considered on its own merits. The sizes and lengths available vary considerably.[3]

The choice of joint fastening will be closely interrelated with the material and the structural form.

The three main devices for fastening timber are nails, connectors and glues. Subsidiary devices are screws and bolts. Full details of the permissible loads are given in the Code of Practice,[1] but a rough idea of the relative strengths of typical fastenings is given in Table I.

TABLE I.—*Permissible Loads with Various Fastenings*

Fastening	Size	Permissible shear load, lb	
		Parallel to grain	Perpendicular to grain
Nail	0·128 in dia.	76	76
Toothplate connector	2½ in dia.	1,385	1,085
Split ring connector	2½ in dia.	2,975	2,105
Glue	1 sq. in	100	30

Adhesives should only be used under strictly controlled conditions, which means that glued structures are generally prefabricated. The choice of adhesive will depend on the atmospheric conditions and the length of life required.

Nails and connectors may be used for complete or partial prefabrication, or site work.

One final point to be borne in mind is that the size of members in many structures will depend not on the direct loads they must carry, but on the ability to join the members together. An examination of the joint forces should therefore be undertaken at an early stage in the design.

All the possible structural forms considered fall into two groups, given in Tables II below and III on the opposite page.

The first of these groups comprises structures which carry their load along the length of their members to the supports. Examples are beams, arches, portals and trusses. Spanning between the primary system (e.g. the truss) will be a secondary system (e.g. the purlins) and finally some form of cladding (e.g. asbestos sheeting).

The second group, Table III, consists of plates and shells. In these structures the load is carried simultaneously in both longitudinal and transverse directions to edge members, and then to the supports. No secondary system or cladding is required.

The choice of structural form will depend on the size of the area to be covered, the supports available, site conditions and architectural considerations. The structures of Table II are more easily prefabricated whereas those of Table III are capable of covering larger areas with fewer supports.

Factors which will influence the cost are the materials available, the ratio of material to labour costs, fabrication methods, site conditions and the functional and architectural requirements of the building.

The use of prefabricated components should lead to a reduction in cost, but transportation problems will generally limit the size of the structure.

The cost of a roof formed with a plate or a shell will generally be higher than that of a roof using beams or trusses. This increase in cost should, however, be balanced by the fact that fewer supports are required and consequently, foundation costs will be lower.

The range of variables is so large that the quotation of costs per square foot could in many cases be distinctly misleading. Each structure must be considered specifically and only by treating each problem according to its merits can definite conclusions be drawn.

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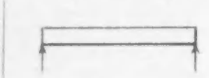
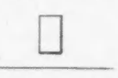
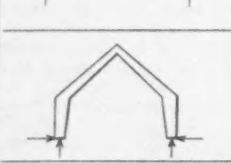
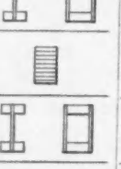
[2] B. A. JAY, "Sizes of Timber," *Wood*, July and August, 1956.
[3] L. G. BOOTH, *Hardwoods for Structural Purposes*. Timber Development Association, London.

TABLE II.—BEAM, ARCH, PORTAL AND TRUSS SYSTEMS

Division	Sub-division	Construction	Minimum Support Conditions	Maximum Economic Spans, ft	Fastenings
Beams		Solid timber	Vertical support at ends	20	None
		Laminated, either vertically or horizontally, depending on size		80	Glue
		I or box sections: flanges solid or laminated. Webs plywood or diagonally boarded		100	Glue and/or nails
Arches		Laminated horizontally	Vertical and horizontal support at ends	150	Glue and/or nails for laminating. Connectors for site joints
		I or box sections: flanges laminated horizontally. Webs diagonally boarded		150	
Portals		Laminated horizontally	Vertical and horizontal support at ends	80	Glue and/or nails for laminating. Connectors for site joints
		I or box sections: flanges solid or laminated. Webs plywood or diagonally boarded		150	
Trusses	*Belgian*	Solid timber	Vertical support at ends	40	Nails and/or glue
				80	Connectors
	Warren	Solid timber		40	Nails and/or glue
				100	Connectors
	Bowstring	Laminated chords. Solid webs		150	Glue and/or nails for laminating. Connectors at joints

Radiation Protection in a Modern Building

The protection from radiation fallout in a basement having unexposed walls may be 200 times greater than that to be had on the fourth storey of the same building. It is also the case that, for similar positions on each floor, it is safer on the first floor than on the ground floor. The dose rate is 5 to 10 times higher just within the window opening than is the average in the room, and close to the average conditions are to be found anywhere beyond about 8 ft from the inner face of an exposed wall.

These are some of the points made in a report issued by the US Atomic Energy Commission following a test made in a modern reinforced concrete office building. (Fallout was simulated by moving a cobalt-60 source around the building to produce the characteristics of a radiation field.)

It was also found that burial of the basement wall, with the surrounding ground graded to a level above the first floor, significantly reduced the radiation penetration. Particular care must also be taken to ensure that the concentration of fallout does not reach danger levels in the air conditioning trunking and drains.

The report, "An Experimental Evaluation of the Radiation Protection Afforded by a Large Modern Office Building," is obtainable from the Office of the Technical Services, US Department of Commerce, Washington, DC (price 60 cents).

Pipelines of Plywood

Plywood pipelines have been successfully used in Russian oil fields where, previously, the high sulphur content of the oil had been causing excessive corrosion of metal pipes. The particular oil field where the change to plywood was first made was at Baku, but the use of these pipes has been extended to other fields.

Similar pipes are also being used for water mains at Lvov, presumably without harm to the water. The pipes are made in Leningrad and in the Urals, and have diameters between 50 and 300 mm (2 in to 12 in in diameter).

Hydro-Electric Power from the Mediterranean

Two hydro-electric power projects are being considered for the Middle East that involve channelling water from the Mediterranean, passing it through turbines and then releasing the below sea level. In the near-tropical areas under water into large natural depressions that are consideration it is thought that evaporation would ensure that the depression would never fill.

As a by-product to the power generated there would be the minerals and salts retrieved after evaporation. Such evaporation might also increase rainfall in the area, so generally improving the land roundabout.

One of these schemes would utilise the Qattara Depression in Egypt. The Depression is 8,000 square miles in extent, is 200 ft below sea level and at its northern edge is only 40 miles from the sea. With an average fall of only 1 in 300 between the sea and the Depression, only very low head turbines would be possible but an extremely high flow could be maintained without any fear that the Depression would become filled. Tentative estimates put the cost of the project at £100 million and the potential at 3 million MWh per annum (compared with 10 million MWh from the new high dam at Aswan). At present the scheme is not much more than a dream, and the capital cost per unit, £33 per MWh per annum, makes it an expensive proposition; Kariba has a potential of 7·6 million MWh a year and will cost £120 million to complete, or less than half per power unit of the Qattara project.

The second scheme is in Israel. Water would be drawn from the sea at Haifa and, after being passed through turbines, would be released into the River Jordan, which runs parallel with the coast about 40 miles inland and empties into the Dead Sea 1,290 ft below the level of the Mediterranean. The river enters the Dead Sea outside Israel, in Jordan, but the southern reaches of the sea are in Israeli territory, where there is an already fast expanding salt and mineral industry.

Lightweight Aggregates for Structural Concrete

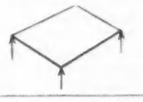
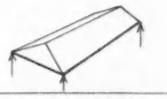
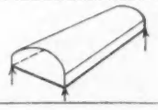
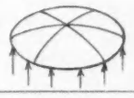
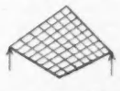
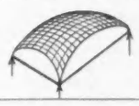
A cubic foot of ordinary concrete weighs about 150 lb, but by using a suitable lightweight aggregate its weight can be reduced to about 100 lb per cu. ft, while still providing enough strength for the concrete to be used structurally and at the same time improving its thermal insulation value.

At a recent meeting of the Reinforced Concrete Association, Professor R. H. Evans and Mr. T. R. Hardwick presented a paper "Lightweight Concrete using Sintered Clay Aggregate," summarising work at the University of Leeds on one of the lightweight aggregates, a sintered clay known commercially as Aglite. As their work was still going on the authors stated that the paper should be considered as in the nature of an interim report. Nevertheless their conclusions were that not only was this material suitable for reinforced and prestressed concrete, but with certain minor reservations, which could be allowed for in design, maximum permissible design stresses should be the same as those allowed in the Code of Practice for reinforced concrete made with conventional aggregates.

During the subsequent discussion several engineers said that Aglite had been used successfully in structures they had designed. Mr. Alan Grant, of Leonard and Grant, the London consulting engineers, stated that his firm was going to use Aglite concrete for the structure of the upper 27 storeys in a 30 storey block so on to be erected in Manchester.-

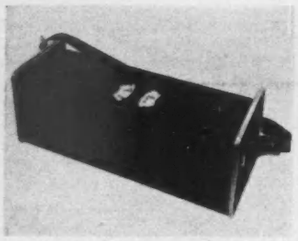
Continuing **Timber Roofs**

TABLE III.—PLATES AND SHELLS

Division	Sub-Division	Construction	Minimum Support Conditions	Max. Economic Sizes	Fastenings
Plates	*Flat* 	Membrane formed from plywood or layers of diagonal boarding. A single-skin structure may have stiffening ribs. A double-skin structure will have spacing ribs. Edge beams and end diaphragms required.	Vertical support at corners	40 ft by 40 ft	Nails and/or glue.
	Folded 		Vertical support at corners	60 ft by 30 ft	Membrane with nails and/or glue. Diaphragms with nails or connectors.
Singly curved shells	*Circular Cylindrical* 	Membrane formed with layers of diagonal boarding. May have stiffening ribs. Edge beams required. End diaphragms required.	Vertical support at corners	100 ft by 40 ft	Membrane with nails and/or glue. Beams (see Table II). Diaphragms with nails or connectors.
Doubly curved shells	*Spherical Dome* 	Boarded membrane with or without laminated ribs. Laminated ring beam.	Ring beam to be supported at intervals.	100 ft diameter	Membrane with nails and/or glue. Ribs and ring beam glued.
	Hyperbolic Paraboloid 	Boarded membrane with laminated edge beams.	Vertical support only at low points, if columns tied together. Otherwise buttresses at low points.	70 ft by 70 ft	Membrane with nails and/or glue. Edge beams glued.
	Elliptical Paraboloid 	Boarded membrane with laminated tied arches along edges.	Vertical support at corners	80 ft by 80 ft	Membrane with nails and/or glue. Tied arches with glue and connectors.
	Conoid	Boarded membrane with laminated tied arches on ends. Edge beams required.	Vertical support at corners	100 ft by 30 ft	Membrane with nails and/or glue. Beams (see Table II). Tied arches with glue and connectors.

FREQUENCY FILTER

Variable Range Bandwidth



THE variable bandwidth filter type 1465 is designed to operate within the range from 20 c/s to 20 kc/s.

The instrument incorporates two independent sections of similar construction, with the exception that the high pass section has the inverse characteristics of the low pass section. Each section is continuously adjustable over the full frequency range, the cut-off selected being shown on a dial.

Two positions of a four position switch enable either section to be individually switched in circuit to give either a high-pass or a low-pass filter. A third position of the switch provides an additional all-pass characteristic to direct connection between the input and output terminals. The fourth setting of the switch brings both sections into circuit simultaneously, to yield a band pass filter with variable band width at all frequencies within the specified range. This facility is useful for obtaining spectra.

Tuning is magnetic over one octave with printed circuit switching to the next octave. In the low pass section, from d.c. to the cutoff indicated, insertion losses range from zero to 1 db at half cutoff frequency and nominally 3 db at cutoff. The figures for the high pass section are the reverse. Outside the pass band, the attenuation rate is at least 20 db in the first octave and more than 25 db beyond. The minimum input level is 2V r.m.s.

Since the filter is a passive network it requires no power supply and is portable and simple to operate. The dimensions are 7 in by 18½ in by 8½ in high and the weight approximately 16 lb. *Dawe Instruments Limited, 99 Uxbridge Road, London, W5.*

AC GENERATOR

For Vehicles

FOR vehicles having a heavy electrical load, as for instance when equipped with two-way radio, a lightweight alternating current generator has been produced.

Even with the associated rectifier the equipment is lighter than a direct current machine of the same output at low speeds. The 2AC weighs only 18¼ lb with its fan, and will generate up to 65A at 12 volts.

The alternator incorporates a stator winding and a rotor field winding energised through a pair of sliprings. This arrangement avoids the problem of collecting heavy currents through a commutator and also allows higher maximum rotational speeds to be achieved. This in turn permits the use of higher driving pulley ratios so that useful output is available at very low road speeds.

The current is rectified by silicon diodes built into the end bracket of the machine and cooled by a 6 in diameter fan which draws air over them and through the generator. The associated control unit model 2TR has a transistor assisted regulator to maintain the output voltage constant over a wide range of speeds. No external current limiter is required nor is a cutout or reverse current relay as the diodes perform this function. The output is controlled to 60-65A when the generator is cold, falling to 52-57A when hot at all speeds up to 11,000 r.p.m. *Joseph Lucas Limited, Great King Street, Birmingham 19.*

HYDRAULIC PUMP

Multicylinder

A NEW high speed hydraulic pump is a multicylinder unit designed to give high pressure at small deliveries.

The pump is of unit construction and is available with from three to six cylinders. Each cylinder has an output of 0·6 gallons per minute when the pump is running at 1,000 r.p.m., a six cylinder unit giving 3·6 gallons per minute. Delivery pressure is 1,000 lb per sq. in. The eccentric shaft of the pump is coupled through a flexible coupling to the driving motor which runs at a synchronous speed of 100 r.p.m.

The pumps are suitable for operation with water, a water soluble oil mixture or with hydraulic oil. The design can be adapted for use with other fluids if required. The units can be provided with spring loaded relief valves or alternatively with automatic unloading valves that enable the pump to run unloaded against closed stop valves. *Joseph Evans and Sons (Wolverhampton) Limited, Culwell Works, Wolverhampton, Staffordshire.*

MACHINE CONTROLLER

Using Logic Boards

TWO new machine tool controllers have been introduced by GEC, one for positioning and the other for sequence operation.

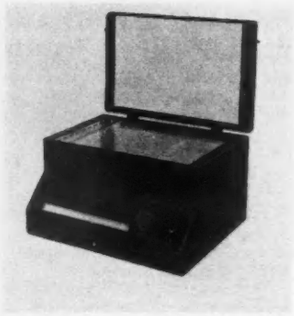
Both systems make use of logic boards and use transistorised circuits with cold cathode valves. They are smaller than conventional equipments, and electro-mechanical control gear is virtually eliminated.

The position sensing is by rotary digitisers whose outputs represent the position of the table in two directions. They control the lead screw driving motors and have two speeds: 90 in per minute for quick traverse and 12 in per minute for homing on to position ± 0·0005 in.

The sequence control provides both timing and triggering facilities for a multiple number of simultaneous and successive operations. Installations have been made on a vertical broaching machine and on an injection moulder. *General Electric Company Limited, Magnet House, Kingsway, London, WC2.*

DOCUMENT COPIER

Choice of Process



MODEL C633 in the new Kopit range of document copying machines has facilities for using either the transfer or the diazo (dyeline) process or for a combination of both.

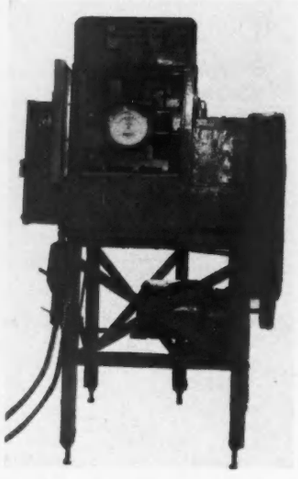
The machine will produce facsimile copies of documents or book pages up to 18 in by 12 in. Its measurements are 23½ in by 15½ in by 12½ in and the weight is 96 lb. The light source is long life cold cathode lamps of sufficient intensity to complete diazo exposures in a few seconds. The exposure time is controlled by an automatic time switch giving accurate repetition when many copies of one item are required.

A complete processor for the transfer process is housed in a drawer under the exposing unit. The operation is with the drawer closed. The drive is electric, and there are slots for single or double-sided copies. Where it is desired to make diazo copies of an opaque or double-sided original a translucent copy is first made on the transfer unit.

Opening the drawer reveals an electrically driven developer for semi dry diazo materials. The feed and delivery are easily accessible with the drawer in the open position. It is claimed that the running costs of this machine are only a fraction of one that operates only on the transfer method. The other two machines in the range are a rotary transfer machine for documents and one for book pages, also using the transfer process. *Hall Harding, Limited, Stourton House, Dacre Street, London, SW1.*

GROSS WEIGHER

For Aerial Ropeways



NOW available is a weighing machine for recording and summing the weights of skips passing along an aerial ropeway.

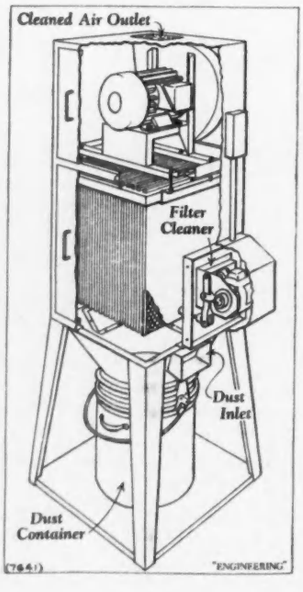
The machine comprises a lever system with a pendulum resistant, pendulum clamping device and the firm's integrator.

When a skip arrives at the weigh rail of the ropeway it trips a switch which releases the weigh pendulum and allows it to take up the position of balance. At the same time, a time relay mechanism is started which clamps the pendulum in its new position before the skip has passed off the rail. The weight is then recorded but the pendulum remains clamped until the next skip arrives. This arrangement means that the pendulum only has to move by the difference in skip weight for each new measurement.

While the pendulum is clamped, the totalising mechanism is engaged with the integrating mechanism and the weights are recorded. A system of levers transmits the load from the rail to the ground level where the machine is usually installed. The totaliser can be isolated from the system if desired. *Adequate Weighers Limited, Bridge Works, Bridge Road, Sutton, Surrey.*

DUST COLLECTOR

Self-Contained Unit



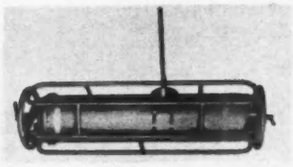
THE Unimaster is a self contained dust collecting unit with a quick release container.

The size at present available has a filter element area of 70 sq. ft. The dust laden air enters at the bottom and passes upwards through the filter. Suction is provided by the fan at the top which has a capacity of 765 c.f.m. at 3·3 in water gauge. Thus the fan only handles clean air and discharges it upwards.

At the side of the filter element is the cleaning mechanism. It is powered by a ¼ h.p. motor which oscillates inserts within the filter pads or envelopes. The inserts are made of rustproof mesh mounted in a rigid frame. The movement induces an air current in the reverse direction through the fabric and frees the dust which falls into the container at the bottom. There are two sizes of container available, of 2 cu. ft and 4 cu. ft capacity held in place by a quick release sealing mechanism. *Dallow Lambert and Company Limited, Thurmaston, Leicester.*

INDUSTRIAL X-RAY UNIT

300 kV Capacity



THE Baltospot G300D is a new lightweight portable X-ray unit of 300 kV capacity; it will view steel up to 3 in thick.

Both insulation and cooling are effected by an inert gas, which results in a light weight tank construction and a high power to weight ratio. The weight is 142 lb. The unit can be supplied with either a conventional 40° solid angle beam insert tube with a fine focus of 3 mm or with a 360° circumferential radiation insert tube. Cooling of the anode is achieved in both cases by forced circulation of the insulating gas by an internal blower.

The tank head is cylindrical in shape and is pressurised and fitted with a pressure gauge so that the gas may be checked at any time. A cradle carries anti-shock mountings. The tube is protected against excessive temperatures by a thermo switch mounted in the tank head. A further device simulates the thermal capacity of the anode and gives a visual indication of overheating. The maximum dimensions are 40 in long by 9 in diameter. The cradle increases the weight to 171 lb. The control unit is made as a carrying case and weighs 60 lb. Its dimensions are 18 in long by 14 in wide by 8 in deep.

The control operates from a 220V 50 cycles single phase supply and will accept fluctuations of $\pm$ 10 per cent. It is fitted with direct reading kilovolt and milliamp meters in addition to a synchronous timer which can be arranged to give automatic repetition of exposures. The voltage and tube controls are of the stepless type giving continuous variable control.

Standard accessories include a telescopic centre finder, end rings for the tank head, protective cradle, mains lead 30 ft long and two 30 ft lengths of control connecting cable. *Pantak Limited, Vale Road, Windsor, Berkshire.*

DIFFRACTOMETER

Multiplane Instrument

A NEW multiplane diffractometer for fully automatic or manual operation is now on the market.

The instrument is designed for research work on crystal structure analysis and incorporates goniometric and scanning movements that allow rapid operation and extreme accuracy. It uses the Schulz method of determining the preferred orientation of crystals which enables the intensities of reflections to be related directly to the number of crystals reflecting. This allows the examination of a specimen in any plane by the simple adjustment of the goniometer ring.

The Geiger counter arm and goniometer ring are carried by concentric bearings, and the gearing between them gives a 2 : 1 angular movement. The ring can be adjusted independantly of the counter arm and then clamped. Rotation of these two items is by hand and two scales give the angle 2θ to one minute of arc. Slit systems are used for the incident and reflected beams.

The gomiometer has a scale inscribed in $\frac{1}{2}°$ and carries the specimen holder and a beam width limiting slit. A special curved slit can be provided for purely diffraction purposes. The instrument can separate an α_1, α_2 doublet less than 6 min apart. *Seton Creaghe Engineering Limited, Great West Trading Estate, Park Royal Road, London, NW10.*

RECTIFIER

With Silicon Control

A SILICON controlled rectifier series, the SCR96, designed for use on power control and power switching applications is now in production.

Blocking voltages up to 200V can be obtained and load currents up to 10A. Series and parallel circuits may be used for higher power applications. The reverse characteristic is similar to that of a normal silicon rectifier but the forward characteristic will block positive anode to cathode voltage below a critical breakover voltage if no signal is applied to the gate terminal. If the breakover voltage is exceeded or a gate signal applied, the device will switch to a conducting state with a low forward drop.

Performance figures are 25, 50, 100, 150, and 200V for the five models, with maximum average forward current of 10A. Typical gate signal to fire is 20 mA at 1·5V. Typical turn-on and turn-off times are 2μs and 15 μs respectively. *General Electric Company Limited, Magnet House, Kingsway, London, WC2.*

PIPE CLAMP

For Fork Truck

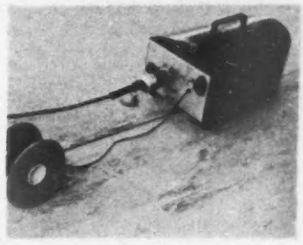
A ROTATING clamp for fitting on a fork truck has been built to take a load of 27,500 lb.

The clamp is intended for handling concrete piles for bridges and other civil engineering structures and is hydraulically operated. Concrete piles up to 61 in diameter are held by 24 rubber pads on the clamp arms, which are of unequal length to facilitate picking the load off the ground. The lifting height is 18 ft. Hydraulic cylinders are used to rotate the clamp on two 11 in roller bearings.

The basic trunk on which the clamp arms are mounted is a Challenger 400 which with standard forks can lift 40,000 lb. With the clamp it weighs over 30 tons. The range of pipe sizes that can be lifted is from 24 in to 61 in in diameter and the truck will lift them from the ground and rotate them through a right angle into the vertical position for placing in the required spot. *Hyster Company, 2902 N.E. Clackamas Street, Portland 8, Oregon, USA.*

SEAM WELDER

Self-Propelled Machine



THE Mouse is a self-propelled machine for welding long seams in plastics floor covering.

The welding rod is made of pvc with a circular cross-section. It is fed in from the back and is laid in the groove between the sections of flooring. The rod is guided into place by the grooved front wheel which then uses it as a rail to guide the Mouse itself.

Inside the machine is a blower that feeds air to the 1 kW heating elements, the outgoing temperature being 500° F. This is sufficient to melt the rod and form the weld, there being a raised bead left above the surface of the floor. An inverted wood chisel is used to remove the bead. The machine will not reach right up to a wall and the last few inches have to be finished off by hand, using a hot air gun and a grooved roller.

The Mouse has a projecting plunger at the front which when striking an obstruction such as a wall, operates a microswitch and stops the forward movement. Main controls are on the back panel.

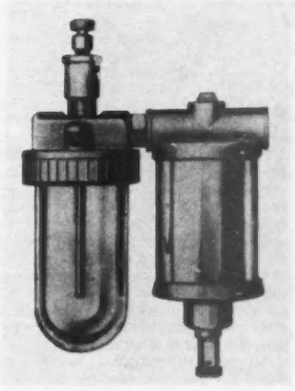
The speed of travel is from 2 ft to 4 ft per minute, under the control of a rheostat. The main and auxiliary contacts are mercury-in-glass and the operation is started by a push button. A thermostat shows the welding air temperature.

The machine weighs 36 lb and its dimensions are 19 in long by 11 in wide and 12 in high.

Particular claims are that it will produce a stronger and more even weld than is possible with hand operation and that it reduces the time required for long seams. *Phoenix Rubber Company Limited, 372 Buckingham Road, Slough, Buckinghamshire.*

LUBRICATOR

For Compressed Air Lines



THE Controlube is a unit designed for supplying lubricant to compressed air lines under strict control.

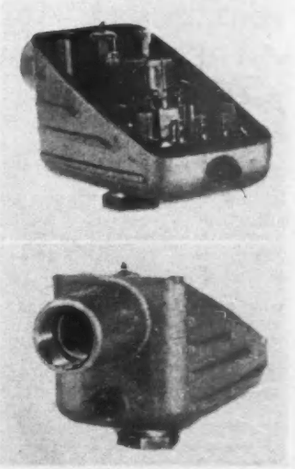
The unit consists of two items, a moisture separator for the efficient removal of condensed water and other impurities from the air supply, and a replaceable bowl lubricator producing an airborne fog of oil. In addition there is a pressure reducing valve for systems that require a lower pressure than that of the main. It is designed to fit between the other two items so that the three form a compact single unit.

The moisture separator is fitted with a replaceable filter element and is supplied with a drain cock. Connections can be either $\frac{1}{4}$ in or $\frac{3}{8}$ in BSP. The lubricator gives automatic control of the flow of oil, and the rate is visible through the sight glass. The rate is adjustable by the screw at the top of the lubricator. Refilling can be carried out without stopping the air flow.

The pressure reducing valve designed to fit between the two units consists of a hand adjusted valve and pressure gauge. A relieving device automatically adjusts the pressure on the downstream side to any valve set on the gauge. A Neoprene diaphragm is used. The handle for setting the downstream pressure projects downwards. *B.E.N. Patents Limited, High Wycombe, Buckinghamshire.*

FLAME DETECTOR

Printed Circuit Construction



THE MacEye light reactive switch offers protection for any gas or oil flame, or for any process control using a light beam.

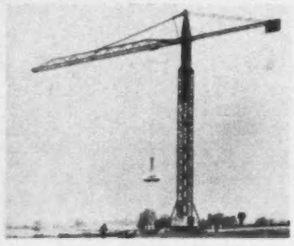
The unit is completely self-contained with all components assembled on a printed circuit base. It includes a shorting switch for starting up and a neon lamp to indicate "flame in" or "flame out." The sensitivity level is adjustable over a wide range of brightness and infra-red radiation is eliminated by the sight filter. A fixed period delay prevents unnecessary operation due to flame flicker.

The cell is a cadmium sulphide unit of high sensitivity which operates a plug-in double-pole changeover relay. The contact rating of the latter is 50 watts at 230V. The life rating is 1 million operations.

To operate, the relay requires a minimum illumination level of 5 ft-candles measured at the tube. Operation is unaffected by ambient temperatutes up to 120° F. Three terminals are provided for external connections. Earthing is through the case. *Urquharts (1926) Limited, 5 Wandsworth Road, Perivale, Greenford, Middlesex.*

TOWER CRANE

131 Ft Outreach



THE Pingon P200 tower crane has a capacity of 4 tons at the full reach of 131 ft.

The crane is self-erecting and when arranged for rail mounting can reach a height of 185 ft under the hook. If it can be anchored, this height can be considerably increased, and if used as a climbing crane becomes virtually unlimited. The reach gives it a coverage from the one position of over 50,000 sq. ft. The maximum load of 15 tons can be taken to a radius of 39 ft 6 in when the full jib is fitted. Alternative jibs are 95 ft and 74 ft long (obtained by removing sections). The minimum radius is 10 ft 4 in from the mast centre.

With an 80 h.p. motor, lifting speeds are 196 ft per minute for loads up to 4 tons and 65 ft per minute for loads above that. Slewing is powered by a 15 h.p. motor and has two speeds—0·82 and 0·41 r.p.m. It can turn through a full circle. The trolley has an 8 h.p. motor and travels at either 125 ft or 62 ft 6 in per minute. The travelling speed on rails using four 4 h.p. motors is 70 ft per minute. Control is possible from the ground and the cabin.

The rail mounting base has four three-wheel bogies on each of which one wheel is driven. A portal frame base is also available or the mast can be mounted direct on a concrete foundation. The outer mast is 8 ft 1 $\frac{5}{16}$ in square, made of box sections each with an effective length of 18 ft 4$\frac{1}{2}$ in. It carries an inner mast on which are mounted the jib and counter jib structures. The inner mast can be raised and lowered within the outer. *George Cohen 600 Group Limited, Wood Lane, London, W12.*

MIXING VALVE

For Hot Water Systems

TEMPERATURE control in many hot water systems is obtained by by-passing all or part of the return flow using a mixing valve of the type illustrated.

The Mixflow has been designed primarily for use in small bore heating systems but can also be used in other applications. The arrangement allows the boiler to run at a high temperature to continue to supply domestic hot water while regulating the temperature in the central heating system. Thermostats give close temperature control with resultant high efficiency.

The valve is arranged to operate from either of two thermostats, one being installed in the living room to run the system at a higher temperature during the evenings, and the other in the hall, set at a slightly lower figure to give general comfort during the day and background heating at night. There is also a boost lever to give a quick rise to full temperature when required. When the full temperature has been reached, the lever is automatically released returning the operation to the control of the thermostats. The valves are suitable for heads up to 100 ft and temperatures up to 200° F. They have non-ferrous moving parts. *Sealed Motor Construction Company Ltd, Bristol Road, Bridgwater, Somerset.*

CARTRIDGE FIXING GUN

¼ In Studs

NOW being made in this country is the Bossong range of cartridge hammer guns and tools.

The gun has a ¼ in barrel and is supplied with two muzzles, one of which is circular at the wall end while the other has a flat side to enable the gun to fix studs close to projections. Both are marked with cross lines to give an accurate centre. The gun will take studs up to ¼ in diameter and up to 3 $\frac{5}{16}$ in long, these last being nails for fixing wood on brickwork or concrete. Rivet bolts for steel and concrete are available up to 1 $\frac{7}{16}$ in long including heads of $\frac{5}{16}$ in, and screw studs of 2 $\frac{5}{16}$ in of which the projecting screwed portion is $\frac{5}{16}$ in.

Six grades of cartridge are made, suitable for driving into materials from soft mortar or brickwork to concrete and heavy steel sections. A hand tool is also made with barrels for ¼ in and $\frac{5}{16}$ in studs. *Bossong Company Limited, 3 and 4 Duxons Turn, Maylands Avenue, Hemel Hempstead, Hertfordshire.*

TEMPERATURE INDICATOR

Self-Balancing

THE latest addition to the Bikini range of instruments is a self-balancing temperature indicator using transistors.

It is a precision instrument with a circular scale and operates from resistance bulbs as the sensing elements. The indicator can be up to 300 ft from the bulb. As the circuit operates at 2,000 c/s no trouble is experienced with mains pick-up.

Since there is no moving coil, the unit is robust and the pointer is set by a servo mechanism. Power is provided by an electric motor which has sufficient torque to ensure that small changes in temperature are followed. A number of standard range scales is available within the range of resistance bulbs (from − 200° C to + 500° C) and non-standard instruments can also be supplied with suppressed zeros and ranges as small as 50° C. The calibration accuracy is 0·5 per cent of range and reproducibility is better than 0·25 per cent. *Fielden Electronics Limited, Wythenshawe, Manchester.*

SOIL PROBE

Density and Moisture

THE d/M Gauge is an instrument for measuring the density and moisture content of soils, working from the surface.

The probes for both measurements use radio active sources, caesium-137 for density and radium-beryllium for moisture. A scaler is used for the count. Measurements can be made in 2 minutes with a repeatability of within 2 per cent. The moisture probe measures a hemispherical volume of material whose depth varies inversely from 5 in to 15 in according to the moisture content. The density probe covers approximately the same volume.

The scaler count is converted to density in lb per cu. ft (or per cent moisture by volume) by calibration curves supplied with the equipment; no calculations are needed. The range of density is from 60 to 160 lb per cu. ft, and of moisture from 0 to 50 per cent by volume or from 0 to 32 lb of water per cu. ft of material. The probes are designed to operate at ambient temperatures ranging from — 20°F to + 140° F and at relative humidities up to 100 per cent.

The density probe (illustrated) measures 12 in by 6 in by 7$\frac{1}{2}$ in (including the handle which actuates the shield for the source) and weighs 20 lb. The moisture probe measures 10 in by 12 in by 7 in high and weighs 30 lb. A separate paraffin standard is used to set up the moisture probe in the field. *Soiltest Incorporated, 4711 West North Avenue, Chicago, Illinois, USA.*

CONSTANT CURRENT SOURCE

Three Ranges

CONSTANT current can be supplied from the model 151 Quan-Tech instrument illustrated.

The current can be regulated and is virtually independent of the voltage drop across the load. There are three ranges, 0·5 to 5; 5 to 50 and 50 to 500mA d.c. The open circuit voltage can be set to any desired value from 0·5 to 20V, thus preventing damage to external equipment. The output voltage can be read directly on the meter by changing a switch on the front panel.

Current regulation is to within 0·25 per cent by transistor circuits. Power input is arranged for 105 to 125V at 50 to 60 cycles, the consumption being 35 watts.

Some suggested applications include semiconductor testing, diode ageing and life tests, transistor beta tests, potentiometer and sensitive relay testing, as a supply for magnets, in strain gauge systems and in general industrial and laboratory work. It is claimed that the rugged construction and the use of transistors give the instrument long life without servicing. *Sylvan Ginsbury Limited, 8 West 40th Street, New York, NY, USA.*

HACKSAW

Cuts up to 6 in Diameter

THE Velox 6 is a new addition to the range of power hacksaws, and will cut up to 6 in diameter stock.

The machine has two speeds of stroke, either 100 or 145 strokes per minute, and the feed is controlled by a single lever placed on the front of the machine. There are three positions, free fall; operating; and automatic return. The drive to the bow is taken from the 1 h.p. motor by means of a single V belt to the jack shaft thence by twin belts to the bow bracket. The sides of the base can easily be removed if it is required to reach the belt drives. The push button for stopping and starting the machine is mounted on the control side.

The bow runs in wide prismatic guides to prevent any twist and to ensure a parallel cut. It will take round or square material up to 6 in diameter and will make cuts at 45° in round material up to 3$\frac{1}{4}$ in diameter and in square material up to 3$\frac{1}{4}$ in by 6 in. The length of the stroke is 5$\frac{1}{2}$ in and the size of blade 14 in by 1$\frac{1}{4}$ in with 6 teeth per inch. The motor is rated at 1 h.p. and runs 1,430 r.p.m. A coolant and tank are included as standard. *B. Elliott (Machinery) Limited, Victoria Works, London, NW10.*

Rising Sun Delayed

During the hundred years since Japan has been in contact with the West it has undergone a remarkable transition which gives the country and its economy a superficial resemblance to conditions found in Europe and North America. Some seventy miles north of Tokyo, at Tokai Mura, a large complex of research laboratories, machine shops and reactor buildings is nearing completion. Nearby a uranium refinery is in operation, capable of producing a ton of metallic fuel per month, and a little further a large site is being cleared for a 150 MW (e) reactor plant. Tokai Mura looks like any other nuclear research complex, be it Windscale, Harwell, Chalk River, Argonne, or Saclay, but the background, the aims and their execution are very different.

Drought and Fuel Shortage

Two events precipitated the entry of Japan into a nuclear programme. One was the general preoccupation with the "energy of the future" throughout the world, that brave new power source that would be cheaper, cleaner, and more abundant than any dreamed of in a Utopia. The other reason was more rational: in 1951 Japan suffered a period of acute power shortage. At that time Japan was producing the bulk of its electricity from hydroelectric power, and 1951 turned out to be the driest year in a long time, with a stream flow 33 per cent below the average of the previous nine years. The shortage of power acted as a brake on the manufacturing industries which were then just beginning to exploit the favourable conditions created by the Korean war. To avoid a similar shortage in the future, Japan embarked on a large power station construction programme, which was to rely heavily on thermal power generation. By 1956 almost 60 per cent of the greatly increased power demand was filled from thermal stations, consuming 49 million tons of coal and some 20 million tons of oil. The domestic fuel reserves of Japan are inadequate and the country is cut off from the nearest foreign mines in China. The only alternatives at that time seemed importing American coal and oil with high transportation costs—or nuclear power.

To Import Experience

With coal prices about twice as high as in the United States, Japan appeared to be the ideal country for a successful nuclear energy programme. All the recognised prerequisites existed: a highly developed industry, an extensive power grid, lack of fossil fuel, and a rapidly growing power demand. By 1954 Japan had sufficiently recovered from the economic disaster of a lost war to start thinking about nuclear research and power plant construction, and to spend some money on it. As a first step the Japan Atomic Energy Research Institute was established, and the laboratories at Tokai Mura constructed and equipped with two American built reactors under the designation JRR-1 and JRR-2. The first, an aqueous homogeneous reactor of the Atomics International L-54 series, became critical in 1957; the second, a CP-5 based reactor supplied by AMF for high-flux research, was completed last year. But even the most extensive research programme imaginable could not have provided Japan with power reactors soon enough, and it became obvious that she would have to rely on foreign experience to bridge the gap left by the post-war years.

Return of the Zaibatsu

It was 1956, the year of Calder Hall, when the Japanese nuclear power programme was first formulated in concrete terms, calling for the installation of over 7,000 MW of electrical generating capacity by 1975. This figure compares with 2,000 MW envisaged by the original, and 6,000 MW by the first revised power programme adopted by the United Kingdom for the first ten-year period. The Japanese planners were clearly impressed by the boldness with which Calder Hall was followed up by Bradwell, Berkeley and Hinkley Point in the United Kingdom, and the gas-cooled graphite-moderated reactor was soon established as a favoured design. In 1957 the Japan Atomic Power Company was set up to implement the programme, and to focus the interests of the Government, the public utilities and the heavy engineering industry. Although the programme was patterned on the British model, the execution was to differ considerably as a result of the peculiar structure of Japanese industry. Before the war, Japan's industry tended to form into large cartels or *zaibatsu* with interests extending into every corner of the economy from primary production to banking. The trend was accelerated during the war, and although during the occupation an attempt was made to split up the *zaibatsu*, the efforts remained largely unsuccessful. The cartels were grown deeply into the economy and only the most drastic surgery could have removed them.

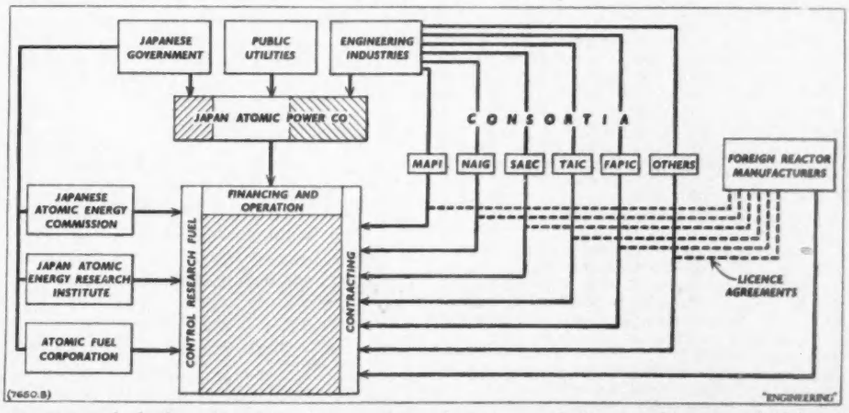
Anatomy of Power

The Government retained only a 20 per cent interest in the Japan Atomic Power Company, the rest was split evenly between the nine regional public utilities and heavy industry. Following the announcement of the large power programme, the industrial

Fig. 1 (left) Sufficient resemblance was found between Japan and Britain to warrant transplanting a reactor programme.

Fig. 2 (below) How to build a reactor: structure of the Japanese atomic energy industry.

FAPIG	First Atomic Power Industry Group (Fuji, Kawasaki)
MAPI	Mitsubishi Atomic Power Industry (Mitsubishi)
NAIG	Nippon Atomic Industry Group (Mitsui, Toshiba)
SAEG	Sumitomo Atomic Energy Group (Sumitomo)
TAIC	Tokyo Atomic Industry Consortium (Hitachi, Showa Denko)



groups organised themselves into the consortia shown in Fig. 2. But unlike their English counterparts, which consist of a functional grouping of companies arranged to supplement each other in every phase of power plant construction, the Japanese groups consist of a vast collection of companies assembled to pool capital as much as manufacturing skills. Among the participants were the three prominent *zaibatsu*, Mitsubishi, Mitsui, and Sumitomo, with all their affiliations and connections, and two heterogeneous groupings based on the heavy electrical manufacturers, Hitachi and Fuji Electric Machinery. Through their large interest in the Japan Atomic Power Company, these consortia could exert a strong influence on purchasing policies. It turned out that Government and consortia were not always in agreement.

An Axe to Grind

As early as 1956 the Japanese government had indicated that it was in favour of purchasing a British designed gas-cooled graphite-moderated reactor. One of the influences affecting the Government's preference was the reality of the British power programme: these stations were in operation and producing electricity, and advanced models were soon to be under construction; while the Americans were still experimenting with newer and newer combinations of fuel, moderator and coolant. Another influence was the fact that the British reactors used natural uranium and offered a chance that Japan might become self-sufficient. A third factor was good sales talk, in which the inherent safety, operating economy, and negative temperature coefficient of the graphite-moderated reactor figured prominently and repeatedly. The preference for graphite-moderated reactors did not suit all the consortia. Japan's trading interests were directed towards the United States and members of the consortia had long-standing licence agreements for generating equipment with the companies that were to play a prominent part in the American nuclear programme. General Electric were part owners of Toshiba (Tokyo Shibaura) before the war, and Toshiba used some of General Electric's designs in hydroelectric plant manufacture. General Electric also have licence agreements with Hitachi, so that at least two companies had a reasonable hope of access to GE's reactor designs. The Mitsubishi group have long been licencees of Westinghouse for conventional plant manufacture and Westinghouse had given indication of willingness to extend the agreement to cover its pressurised water reactors as well. On the British side, only Babcock and Wilcox had connections with Hitachi. As a result, the Japanese consortia had some very expensive axes to grind, and the stones for the purpose were soon provided by developments in the United Kingdom.

Calder Hall Reviewed

The Windscale incident at the end of 1957 made Wigner energy a household word in engineering circles, and although not directly connected with the nuclear physics of graphite-moderated reactors, it did cast some doubt upon the matter of "inherent safety." Then the bottom fell out of the claim of a negative temperature coefficient, resulting in a revision of the reactor control requirements at added cost. Claims of operating economy were also becoming increasingly vulnerable to attack in view of the losses indicated by some British consortia on power station contracts, the changes in conventional generating costs and slackness in world shipping. Finally Wigner growth turned into Wigner shrinkage and some doubts were raised about the ability of an externally braced graphite core to withstand earthquake forces under these conditions. Individually, none of these events would have had much effect on the future of the gas-cooled graphite-moderated reactor as an export commodity, but the cumulative effect was increased caution in Japanese circles. And by that time the American sales drive was in full swing.

Firm Plans for Two Plants

The Japan Atomic Power Company was clearly beginning to have second thoughts. Originally it was planned that negotiations for an improved

Calder Hall reactor should be completed early in 1959 but were in fact drawn out to the end of the year. The power programme itself has not yet been officially revised and still stands at 7,000 MW by 1975, but nobody appears to take the figure seriously and an editorial of the *Asahi Shimbun* predicted that official revision and a more flexible policy would soon follow. The only firm plans now concern the 150 MW(e) station at Tokai Mura, supplied by GEC-Simon-Carves and erected in conjunction with the First Atomic Power Group based on the Fuji-Kawasaki industrial complex. A boiling-water power demonstration plant of 12·5 MW(e) output to be supplied by the International General Electric Company and built by the Nippon Atomic Industry Group is currently under negotiation and will be known as the Japan Power Demonstration Reactor (JPDR). For the future it is strictly "wait and see," and representatives of the Japan Atomic Power Company, who were here early this month to sign a fuel agreement with the UKAEA, made it clear that the next steps would depend entirely on the performance of the two power reactors.

Secondary Industries Emerge

As a result of the changes in the power programme the picture of the Japanese atomic energy industry has changed completely. Instead of being an export market for large power stations, Japan will develop her own industrial capacity and undertake independent research. Since 1957 plans were drawn up for a third reactor for Tokai Mura, this time entirely designed and built in Japan. JRR-3 will be a high power reactor for component testing and isotope production. Skipping the first generation of power reactors, the research institute is now concentrating on breeder reactors to overcome the uranium shortage in Japan and high-temperature reactors with semi-homogeneous fuel to reduce electrical generation costs. (Atomic Review, 26 Feb. '60.) Spending on nuclear research is at a continued high level and as a result the secondary industries of graphite and heavy water production, isotope applications, instrumentation, and radiation processing have grown to impressive proportions. The consortia are contracting for various projects in Tokai Mura and steadily gaining experience. In addition, many undertake research under contract to the Japan Atomic Energy Research Institute. The result of such efforts can only be Japanese self-sufficiency in nuclear engineering and closing of Japan as an export market.

Ready With a Nuclear Ship

The other major field of application for nuclear power is marine propulsion, in which Japan, one of the leading maritime nations, has a particularly large stake. Under the direction of the Ministry of Transport a committee on nuclear ships was set up, which recommended a programme of design and research to be undertaken jointly by the Government and private industry. It is likely that an order will be placed for a prototype propulsion reactor either at home or abroad, and that in 1961 construction will start on the first ship. Design studies have been carried out by numerous combinations of shipping firms, shipyards and members of the nuclear consortia, and include ore carriers, submarine tankers, dry cargo and passengers ship and ocean-going research vessels from 4,000 to 60,000 tons displacement, with power plants from 35 to 180 MW(t). Kawasaki have constructed a working model of a direct-cycle boiling-water reactor using steam as heat source and employed in the study of control response of a forced circulation BWR in the place of an electronic analogue. Whether a nuclear ship will be built in two years time, as predicted by various sources, depends to a large extent on what other nations will be doing and on the position of world shipping. But it is certain that when a demand arises for nuclear ships, Japan will have the equipment to fill it.

Notes and News

Peaceful Projects for Explosions

It is now indicated that the USAEC will carry out its projected experiment for the utilisation of heat released by a nuclear explosion. (Atomic Review, 6 Nov. '59.) The test would be performed underground in salt strata near Carlsbad, New Mexico, and the possibility of heat recovery and isotope production from a 10 kiloton explosion would be examined. The earth-moving project by nuclear explosions, in which a new harbour would be created in Alaska has not been definitely revived as surface explosions would involve a degree of atmospheric contamination, while underground tests can be fully contained. The economic justification of the Alaskan harbour project is also doubtful. A better application for nuclear explosions is offered by the Egyptian project for creating a channel across the North African strip of land separating the Qattara Depression from the Mediterranean Sea. The depression, lying 200 ft below mean sea level, would be filled up through a set of water turbines. With the high rate of evaporation under desert conditions, the turbines could be operated continuously and would generate, it is estimated, one third of the capacity of Aswan High Dam.

Direct-Cycle Gas-Cooled Reactor Critical

Aerojet-General Corporation announce that the company's direct-cycle gas-cooled reactor experiment was brought to criticality for the first time on 23 February and has been operated at zero power since. The reactor is water-moderated and cooled by nitrogen, with a design power rating of 2·2 MW(t). The experiment is directed at obtaining operating experience with direct-cycle reactors in preparation for a prototype gas-turbine power plant being developed for the US Army Corps of Engineers as a mobile source of power. The Mobile Low-Power Nuclear Power Plant No. 1, also an Aerojet-General project, will develop 400 electrical kilowatts and will serve as a test-bed for gas turbines operating on a reactor coolant. The entire power plant will be transportable in four packages totalling less than 38 tons. The specifications call for sufficient shielding to permit relocation only 24 hours after shutdown, simplicity of operation and maintenance by army technicians, and reliability suitable for military field conditions.

International Projects and Scientific Turnover

To share the extremely high development costs of nuclear projects by international undertakings similar to Dragon and the Halden reactor projects seems an excellent idea. The second report of the European Nuclear Energy Agency (ENEA) points out one difficulty associated with such undertakings: very high staff turnover. Smaller nations for whom the joint undertaking may be the only field of active participation in nuclear development will tend to use the projects as a training ground for scientists, For this purpose a high rate of turnover is desirable, while the project itself needs a permanent staff for efficient functioning. At Halden a minimum contract time of 18 months was reached as a compromise, but every effort is made to keep key personnel for longer periods.

Waste Disposal in Sandstone

It is suggested that layers of sandstone lying below the ground water table could be used to remove radioactive materials from aqueous wastes. If successful the method would offer a cheap alternative to holding large quantities of low-activity waster or processing in ion-exchange columns. The wastes would filter through the sandstone layer depositing the contained minerals, and would be returned to the ground water in a purified state. The method was developed and tested in the field by Professor B. B. Ewin of the University of Illinois and Professor W. J. Kaufmann and J. V. Kerrigan of the University of California.

Revisions to the SENN Boiling Water Reactor

It was briefly reported in Atomic Review on 19 February this year that the power rating of the boiling-water reactor supplied to Societa Elettro Nucleare Nazionale (SENN) by the Internation General Electric Company will be increased from 150 to 230 MW in order to qualify for aid under the US-Euratom programme, funds for which were left partially idle as a result of the poor response to the American offer in Germany. Details of the assistance extended to SENN have been reported by a special correspondent of *The Times* on 18 March. The initial charge for the enriched fuel will be $11 million, calculated at American domestic prices. Important concessions are made in repayment, which will be in ten yearly instalments, with the first payment due only in the eleventh year after start of electricity generation. An interest charge of only 4 per cent per annum will be made during the interim period. According to the report, the modifications to the reactor design necessary to raise the output can be incorporated at this stage without undue expense and will leave the construction schedule unaffected. It is hoped that considerable economies will result from the increased unit size.

Policing Alpha Emitters

When a filter paper taken from a laboratory air monitor yields a high gross alpha count, it is essential to identify the alpha emitter present on the filter paper as soon as possible. The filter paper itself may be used as a source in the identification by direct alpha pulse analysis. Alternatively, a source may be prepared by wet oxidation of the paper followed by suitable chemical treatment. The two methods are usually used in series, the second method performed only when supplementary chemical evidence is required for the identification. Direct alpha pulse analysis is preferred because of its speed, improved resolution and the reduction in statistical errors which may enter during the chemical processing. (K. M. Glover: "The Identification of Alpha Activity Detected on Laboratory Air Monitors and Comparison of Suitability of Different Types of Filters," AERE Report M589, HMSO, 1*s* 9*d*)

Czechoslovak Gas-Cooled Heavy-Water Reactor

A power station of 150 MW(*e*) capacity is now in its third year of construction at Bohunice in Czechoslovakia and is expected to go critical by 1963. The plant will be cooled by carbon dioxide at a pressure of 882 lb per sq. in (60 atmospheres), and uses heavy-water moderator and natural-uranium fuel with a maximum surface temperature of 500° C (930° F). A schematic arrangement of a gas-cooled heavy-water moderated reactor is shown in Fig. 3. Thermal output of the station is 590 MW, giving an overall efficiency slightly better than 25 per cent. Power will be generated in three turbogenerator sets of 50 MW rating, and it is claimed that the steam conditions are sufficiently good to permit the use of standard turbo-components. An interesting feature of the steam-raising units is the use of bare heat-exchanger tubing. It is claimed that as a result of the very high primary-coolant pressure, heat transfer is adequate while pressure losses are lower in this design. The gas circulators are single-stage axial blowers with overhung rotors and variable pitch blades. Fully automatic control is envisaged for the plant.

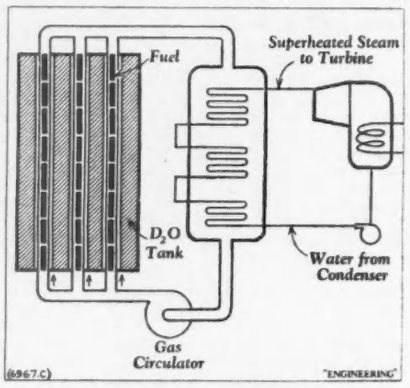


Fig. 3 Schematic arrangement of a gas-cooled heavy-water moderated reactor similar to that built at Bohunice in Czechoslavakia.

Reactor Notes

Public Inquiry for Oldbury Site: The Minister of Power has appointed Mr. A. H. F. Linton and Mr. C. D. Buchanan to hold a public inquiry into the proposal to build a nuclear power station at Oldbury, Gloucestershire. The date of the inquiry will be 12 April.

Training for Italians: Arrangements have been made to train Italian operators for the Latina power station at the Calder Hall operations school. Seventeen future Latina staff members will receive training, and the possibility of extending this service to the operators of the other British export reactor at Tokai Mura is now under discussion. Comprehensive operator training facilities may well turn out to be an excellent selling point for British reactors abroad.

Equipment for the AGR: The UKAEA has placed an order valued at £145,000 with Mitchell Engineering for the supply and erection of civil engineering work, steam generation plant, buildings and oil tank farm with ancillary equipment for Windscale.

Reactor for Australia: Following the criticality of Australia's high-flux material testing reactor HIFAR, the Australian Atomic Energy Commission has announced its intention to purchase a second reactor. The new reactor would have a power rating in the watt range and would be used for low-flux research. The announcement is in parallel with the steps taken by Denmark, who have (1) recently brought to criticality DR-3, a reactor similar to HIFAR; and (2) announced purchase of a JASON reactor from Hawker Siddeley for low-flux research.

AEI

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quoting reference S.3.

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'Engineering' Appointments Section

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CITY OF CARLISLE

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Applications are invited for the following new posts which arise owing to expansion of the work of the College:—

"GRADE B" ASSISTANT IN PRODUCTION ENGINEERING, to teach Workshop Technology and Principles of Engineering Production. Applicants should be graduates or equivalent, and have had good industrial experience in production engineering. Salary £700 by £27 10s. to £1150.

"GRADE A" ASSISTANT IN WORKSHOP ENGINEERING, to teach Workshop Practice and technology. Workshop experience is essential, and candidates should possess a Full Technological Certificate in Machine Shop Engineering or H.N.C. in Mechanical Engineering. Salary £520 by £27 10s. to £1000 p.a.

Allowance will be made on the scale for approved industrial experience and qualifications.

Application forms and further particulars from the DIRECTOR OF EDUCATION, 19, FISHER STREET, CARLISLE. Closing date 12th April.

B 654

SCIENTIFIC OFFICER

D.S.I.R. required SCIENTIFIC OFFICER/SENIOR S.O. for Project Appraisal/Design Study at Warren Spring Laboratory, Stevenage, Herts., as member of team carrying out economic assessment of new projects based on operational research and statistical studies. Candidates should have strong interest in economics and be familiar with statistical techniques but not necessarily economists or statisticians. Flair for formulating or programming design problems of chemical engineering nature desirable with an appreciation of basic technical processes involved. Laboratory's present interests are centred mainly around inorganic applied chemistry and include chemical engineering, process development, mineral processing and extractive metallurgy. Quals.: 1st or 2nd Class Hons. degree in Chemistry, Chemical Engineering, Economics, Physics or Metallurgy or equiv. Min. 3 years post-grad. experience for S.S.O. Salary: (men) S.O. £615-£1090, S.S.O. £1166- £1380. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting reference F 782/9A.

B 649

UNIVERSITY OF KHARTOUM

LECTURERS

Applications are invited for a SENIOR LECTURESHIP *or* LECTURESHIP IN THE DEPARTMENT OF ENGINEERING MATHEMATICS; LECTURESHIP IN ELECTRICAL ENGINEERING; SENIOR LECTURESHIP *or* LECTURESHIP IN MECHANICAL ENGINEERING.

SALARY SCALES:

Senior Lecturer: £8.2052 by 75 to £8.2127 p.a.
Lecturer: £8.1077 by 75 to £8.1977 p.a.

Entry point according to qualifications and experience. Cost of living allowance approximately £8.180 p.a. Outfit allowance £8.50. Family allowances: Wife £8.60 p.a., 1st child £8.90 p.a., 2nd and 3rd child £8.30 p.a. each (£8.1 = £1 0s. 6d. sterling). Passages for appointee and family on appointment, termination and annual leave. Initial appointment 5 years, with possible renewal. Superannuation scheme; arrangements can be made to maintain F.S.S.U. policies. Unfurnished accommodation provided at rent up to 7½ per cent. of salary.

Applications (10 copies) detailing qualifications and experience and naming three referees by 20th April, 1960, to REGISTRAR, UNIVERSITY OF KHARTOUM, c/o INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS, 29, WOBURN SQUARE, LONDON, W.C.1, from whom further particulars may be obtained.

B 646

EXPERIMENT OFFICERS

The SCIENTIFIC CIVIL SERVICE seeks men or women for pensionable posts as (*a*) EXPERIMENTAL OFFICERS and (*b*) ASSISTANT EXPERIMENTAL OFFICERS in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on 31.12.60, be at least 26 and normally under 31 for (*a*), and at least 18 and normally under 28 for (*b*). Qualifications should normally include H.S.C., or G.C.E., or equivalent, or H.N.C. or University degree. Provisional admission if taking examinations in 1960. Men's salary scale (London) (*a*) £1005-£1233; (*b*) £397 10s. (at 18) to £710 (26 or over) rising to £880. Promotion prospects. Further education facilities. Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/94-95/60.

B638

ST. ALBANS COLLEGE OF FURTHER EDUCATION

AND

HERTFORDSHIRE COLLEGE OF BUILDING

LECTURER

Applications are invited for the following posts for September, 1960:—

ENGINEERING DEPARTMENT

LECTURER in Mechanical Engineering. Candidates must be prepared to organise and develop both Day Release and Evening Classes. Ability to teach Aeronautical Engineering subjects to O.N.C. level would be an added recommendation. Applicants should possess an Engineering Degree or equivalent and have adequate teaching experience. Salary: Burnham Technical Scale: £1370 by £35 to £1550.

Assistant, Grade B, to teach City and Guilds Machine Shop Engineering to Intermediate Standard to Day Release students. The College has a new and well equipped Machine Shop. Preference will be given to candidates with City and Guilds Full Technological Certificate, with adequate teaching experience and training.

Salary: Burnham Technical Scale: £700 by £27 10s. to £1150.

Application forms should be obtained from THE PRINCIPAL, to whom they should be returned as soon as possible.

B 660

UNIVERSITY OF CAMBRIDGE

GRANT FOR A STUDENT OF CHEMICAL ENGINEERING

Applications are invited for a grant offered by CONSTRUCTORS JOHN BROWN LIMITED to enable a student to devote himself to full-time study and training for research in the DEPARTMENT OF CHEMICAL ENGINEERING OF THE UNIVERSITY OF CAMBRIDGE. The value of the grant will be sufficient to maintain the student and pay his University and College fees for a period depending on the course of study or research which he intends to pursue. Further information may be obtained from the SECRETARY, DEPARTMENT OF CHEMICAL ENGINEERING, PEMBROKE STREET, CAMBRIDGE, to whom applications for the grant must be sent so as to reach him not later than 30th April, 1960.

B 652

UNIVERSITY OF KHARTOUM

CHAIR OF MECHANICAL ENGINEERING

Applications are invited for the CHAIR OF MECHANICAL ENGINEERING.

SALARY: £8.2760 per annum.

Cost of living allowance approximately £8.180 p.a. Outfit allowance £8.50. Family allowance: Wife £8.60 p.a., 1st child £8. 90 p.a., 2nd and 3rd child £8.30 p.a. each (£8.1 = £1 0s. 6d. sterling). Passages for appointee and family on appointment, termination and annual leave. Superannuation scheme; arrangements can be made to maintain F.S.S.U. policies. Appointment on contract for 5 years with possibility of renewal. Unfurnished accommodation provided at the rate of 7½ per cent. of salary.

Applications (10 copies) detailing qualifications and experience and naming three referees by 20th April, 1960, to REGISTRAR, UNIVERSITY OF KHARTOUM, c/o INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS, 29, WOBURN SQUARE, LONDON, W.C.1, from whom further particulars may be obtained.

B 645

UNIVERSITY OF KHARTOUM

TUTORIAL DRAUGHTSMAN

Applications are invited for the position of TUTORIAL DRAUGHTSMAN IN THE DEPARTMENT OF MECHANICAL ENGINEERING.

SALARY SCALE: Either—

Senior Technician: £8.1250 by 50 to £8.1500 p.a.
Technician: £8.950 by 50 to £8.1200 p.m.

Entry point according to qualifications and experience. Cost of living allowance now approximately £8.180 p.a. Outfit allowance £8.50. Family allowance: Wife £8.60 p.a., 1st child £8.90 p.a., 2nd and 3rd child £8.30 p.a. each (£8.1 = £1 0s. 6d. sterling). Passages for appointee and family on appointment, termination and annual leave. There is a superannuation scheme, and arrangements can be made to maintain F.S.S.U. policies. Appointment on contract for 3 years with possibility of renewal. Unfurnished accommodation provided at rent up to 7½ per cent. of salary.

Applications (10 copies) detailing qualifications and experience and naming three referees by 20th April, 1960, to REGISTRAR, UNIVERSITY OF KHARTOUM, c/o INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS, 29, WOBURN SQUARE, LONDON, W.C.1, from whom further particulars may be obtained.

B 644

Ferranti Ltd

have the following vacancies for

MECHANICAL ENGINEERS

for

RESEARCH and DEVELOPMENT at their Oldham Branch

1. **PROJECT LEADER** possessing good academic qualifications in mechanical engineering and with experience of the development of small mechanical and electromechanical devices. The work is concerned with high precision clockwork timing mechanisms.

2. **TECHNICAL ASSISTANTS** with at least H.N.C. in mechanical engineering for work in the same field.

These appointments carry salaries commensurate with experience and qualifications. A Staff Pension Scheme and a Dependants Insurance Scheme are in operation.

Forms of application can be obtained from—

T. J. LUNT, Staff Manager,
FERRANTI LTD.,
HOLLINWOOD, LANCS.

Please quote reference FCA. B 612

MECHANICAL ENGINEERS

An expanding Company operating on a continuous process basis has vacancies for two well qualified mechanical engineers in London and South Wales. Applicants should have sound experience in heavy engineering and in addition to their technical qualifications should have attained a good level of general education. The age limit is 32 and an attractive commencing salary is being offered. Write stating brief details to BOX B 653, Offices of ENGINEERING.

Mechanism Development Engineers

There are vacancies for graduates or persons with equivalent qualifications in mechanical engineering, physics, mathematics.

The establishment specialises in the science of mechanism:—analyses and design of linkages, stress analyses, resonance and analyses of motion, etc. Development of mechanisms applied to the motor car, involving the dynamic behaviour of body structures.

Development commitments have international scope and therefore applicants should be prepared to make occasional journeys to the Continent. Working conditions are excellent and transport is available to and from the laboratories. Posts carry monthly staff status, competitive salaries, staff pension scheme, etc. Applications, which will be treated in strict confidence, should state age, qualifications and experience and be addressed to:—

Chief Development Engineer,
Wilmot Breeden Limited,
Umberslade Park, Solihull, Warwickshire. B 618

WILMOT BREEDEN LABORATORIES

KINGSTON UPON HULL EDUCATION COMMITTEE COLLEGE OF TECHNOLOGY

Principal: EMLYN JONES, M.Sc., F.R.I.C.

LECTURERS

Applications are invited for the following posts: (*a*) SENIOR LECTURER OR LECTURER, according to qualifications, in NAVAL ARCHITECTURE. Applicants should be university graduates with honours in Naval Architecture and teaching and/or industrial experience. Corporate Membership of the Institution of Naval Architects a recommendation.

Salary: Burnham Technical Scale—Senior Lecturer: £1550 by £50 to £1750. Lecturer: £1370 by £35 to £1510 by £40 to £1550.

(*b*) LECTURER IN ELECTRICAL ENGINEERING to teach to degree and Higher National Certificate standard. Candidates should be honours graduates with experience of heavy current and control systems.

Salary for Lecturer: Burnham Technical Scale—£1370 by £35 to £1510 by £40 to £1550

(*c*) ASSISTANT (GRADE B) FOR ELECTRICAL ENGINEERING to teach electrical telecommunications and allied subjects to Ordinary National Certificate and Technicians' Certificate standards.

(*d*) ASSISTANT (GRADE B) FOR MECHANICAL ENGINEERING. Candidates should have industrial experience and be qualified to lecture to Ordinary and Higher National Certificate and Diploma classes in Mechanical Engineering *or* to lecture to National Certificate students in Naval Architecture and participate in the general work of the Department.

Salaries for Assistants (Grade B): Burnham Technical Scale—£700 by £27 10s. to £1112 10s. by £37 10s. to £1150, with additions for training and graduate qualifications and increments for suitable teaching and industrial experience.

Further particulars and application forms, to be returned as soon as possible, may be obtained from the CHIEF EDUCATION OFFICER, GUILDHALL, KINGSTON UPON HULL. B 625

MINISTRY OF AVIATION

MINISTRY OF AVIATION requires ENGINEERS AND CHEMISTS/METALLURGISTS as Technical Assistants in inspectorates to undertake training for executive responsibility, and practical use of tools of management. Vacancies in various parts of Great Britain. Duties (*a*) inspection of armament stores, including development of new techniques and skills and metrology of components made to fine limits, or (*b*) technical direction of inspection of tracked and wheeled vehicles and Royal Engineer equipment and stores. Qualifications: Preferably not more than 32 years of age and British of British parents. Engineers—engineering apprenticeship and exemption from the graduate membership examinations of the Institution of Civil, Mechanical or Electrical Engineers. Chemists—suitable training and exemption from graduate membership examinations of the Royal Institute of Chemistry, Institution of Metallurgists, Institute of Physics, or Institution of Chemical Engineers. Candidates required to produce documentary evidence of qualifications on interview. Prospects: Opportunities for promotion and establishment in professional Classes for appropriately qualified candidates through Civil Service Competitions. Salary: £595-£950 per annum according to age and location. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C.260/OA and stating preference (*a*) or (*b*) above, and location. Closing date 14th April, 1960. B 650

BOROUGH POLYTECHNIC BOROUGH ROAD, S.E.1.

Principal: JAMES E. GARSIDE, M.Sc.Tech., Ph.D., F.R.I.C., F.I.M., F.Inst.F.

The Governors invite applications for the following appointments:

DEPARTMENT OF ELECTRICAL ENGINEERING AND PHYSICS

Head of Department: V. PEREIRA-MENDOZA, M.Sc.Tech., M.I.E.E.

LECTURER IN ELECTRICAL ENGINEERING

Applicants should be University Graduates in Electrical Engineering and have had responsible industrial, research and/or teaching experience. Specialised knowledge and experience in Electrical Power Engineering is required for lecturing to Dip. Tech. and Part III I.E.E. courses and for developing research projects in this field. Excellent research facilities.

DEPARTMENT OF MECHANICAL ENGINEERING

Head of Department: G. L. H. BIRD, B.Sc. (Eng.), M.I.Mech.E., M.Inst.R.

TWO LECTURERS IN MECHANICAL ENGINEERING

Applicants should be University Graduates in Mechanical Engineering and have had responsible industrial, research and/or teaching experience. Duties will involve advanced "Sandwich" courses. Excellent opportunities and facilities for research.

For one post the Lecturer will be mainly concerned with Engineering Production subjects. A Post-Graduate or professional qualification in Production Engineering would be an added qualification, together with specialised knowledge and experience in some aspect of this subject.

For the other post, the Lecturer will be mainly engaged upon Engineering Thermodynamics and Heat Transfer Theory, and appropriate knowledge and experience is expected.

SALARY (MEN)

Lecturers, within the range £1408 to £1601 per annum. The point of entry on the salary scale and the maximum depending on age, qualifications, training and experience.

Further particulars and Application Form, which should be returned as soon as possible, obtainable from the undersigned.

FREDK. J. PACKER,
CLERK TO THE GOVERNING BODY.
B 622

ASSISTANT (SCIENTIFIC)

ASSISTANTS (SCIENTIFIC). Pensionable posts for men or women at least 17½ and normally under 26 on 1.1.60 with appropriate educational or technical qualifications (normally G.C.E. with passes at "O" or "A" level in 4 distinct subjects including English Language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 2 years' experience in either: (i) engineering or physical sciences, or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing. Starting salary (men, London) from £347 10s. (at 17½) to £550 (at 25 or over). Maximum (London) £715. Promotion prospects. Five-day week generally.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/59/60. B 606

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF LECTURER OR ASSISTANT LECTURER IN MECHANICAL ENGINEERING

The Governing Body invites applications for a LECTURESHIP OR ASSISTANT LECTURESHIP in Mechanical Engineering in the Manchester College of Science and Technology, with corresponding title and status in the University of Manchester.

The Department covers a very wide field in Mechanical Engineering, including Photoelasticity, Fatigue, Servo-mechanisms, Vibrations, Machine Tools and Production Processes and Heat Transfer. A special high level Diploma Course in Machine Tool Design, lasting two years, has just been inaugurated. All members of staff are expected to undertake, assist in or supervise research for which facilities are excellent. The Teaching is almost entirely confined to Graduate and Post Graduate Courses for Internal Degrees and Diplomas. Short courses for specialists in subjects of particular interest are offered each year. Salary, according to qualifications and experience, in the scale £900 by £50 to £1350 by £75 to £1650 (Lecturer) or £700 by £50 to £850 (Assistant Lecturer). F.S.S.U. and family allowances.

Conditions of appointment and form of application may be obtained from the REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, SACKVILLE STREET, MANCHESTER, 1. The last day for the receipt of applications is Saturday, 16th April, 1960. B 617

14th March, 1960.

THE HIGH COMMISSION OF INDIA, LONDON

LEADING DRAUGHTSMAN

Applications are invited for one post of LEADING DRAUGHTSMAN (ENGINEERING) to work in the Railway Adviser's Department, Acton, W.3.

The current salary scale for the post is £865 by £30 to £1015 per annum. Candidates should be of Indian nationality, not less than 26 years of age, and have had a minimum period of seven years' experience in a drawing office with special reference to locomotives, carriage and wagon, cranes and rolling stock equipment.

Terms and conditions of appointment and forms of application may be obtained from ESTABLISHMENT DEPARTMENT (BRANCH I), INDIA HOUSE, ALDWYCH, LONDON, W.C.2. (TEMple Bar 8484.) The last day for receipt of applications is 9th April, 1960. B 643

AIR MINISTRY

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and M.T.C.A. Stations. The work of Station Engineer (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineer (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Commencing salary according to age, qualifications and experience. Salary ranges £680 to £850. Candidates must hold O.N.C. Electrical or Mechanical/City and Guilds Electrical Technicians Certificate/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience. Opportunities for promotion up to Technical Grade A, maximum salary £1565 (National Rate) and pension prospects. Five-day week, three weeks three days leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applications normally from natural born British subjects only, up to age 55 years.—Write, stating age, qualifications and experience, to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 845

GOVERNMENT OF MAURITIUS

FACTORY INSPECTOR AND TRADE TESTING OFFICER (male, aged 30 to 45) required, to be responsible to Labour Commissioner and to perform duties assigned by Commissioner. Duties to include administration of Factories and Apprentices Ordinances and responsibility of a trade testing scheme. Candidates must possess Corporate Membership of Institution of Mechanical Engineers *or* Graduateship of Institution *or* Engineering degree or diploma recognised as granting exemption from Associate Membership examination of the Institution *and* at least two years' training in industrial mechanical engineering workshops *or* corporate membership or graduateship of Institution of Engineering, Australia. In the case of candidate possessing latter qualification he must have had at least two years' practical experience. A working knowledge of French would be an advantage. Post on contract (resettlement grant terms). Salary scale, £1089-£1665 p.a. Quarters available at low rental. Tour of service 3 years. Low income tax.—Further particulars and application forms from DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, quoting BCD.132/52/04/05. *Candidates should state their full names when applying.* B 565

CIVIL, STRUCTURAL AND PUBLIC HEALTH ENGINEERS

CIVIL, STRUCTURAL, AND PUBLIC HEALTH ENGINEERS. Pensionable posts for men and women at least 25 and under 35 on 1.1.60 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/64-66/12. B 605

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON and PROVINCES ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially. Overseas tours for which special allowances granted.

Salary in LONDON ranges from £680 (at age 25) to £900 p.a. for men; from £673 to £868 p.a. for women. Somewhat lower in PROVINCES. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 846

CENTRAL ELECTRICITY GENERATING BOARD

EASTERN DIVISION

SENIOR DRAUGHTSMAN

Applications are invited for the following appointment at Divisional Headquarters (Cockfosters).

SENIOR DRAUGHTSMAN

Salary N.J.B., Schedule D, Grade 5, £830 by £20 to £940 inclusive of London Weighting.

The duties of the successful applicant will include work on the layouts for high voltage transmission lines and substations.

Applicants should have technical qualifications to the standard of Ordinary National Certificate and should have had experience of this type of work.

Applications, quoting Staff Vacancy Number 1287, stating age, qualifications, experience and present position should be sent to the CONTROLLER, CENTRAL ELECTRICITY GENERATING BOARD, EASTERN DIVISION, WEST FARM PLACE, CHALK LANE, COCKFOSTERS, BARNET, HERTS., to arrive not later than 2nd April, 1960. B 629

SCIENTIFIC OFFICERS

The SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (*a*) SENIOR SCIENTIFIC OFFICERS and (*b*) SCIENTIFIC OFFICERS in all major scientific fields, including Physics, Chemistry, Biology, Meteorology and Mathematics. Age limits: (*a*) at least 26 and under 32, (*b*) at least 21 and under 29. Extension for regular Forces Service and Overseas Civil Service. Qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally for (*a*), at least 3 years' relevant (e.g. post-graduate) experience. London salaries (men): (*a*) £1233-£1460, (*b*) £655-£1150; provision for starting pay above minimum. Promotion prospects. Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting (*a*) 8/53/60, (*b*) 8/52/60. B 637

DRAUGHTSMAN

Applications are invited for the above post, which located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733-£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the INDUSTRIAL RELATIONS OFFICER, WEST MIDLANDS GAS BOARD, 6, AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15. G 848

MIDDLESEX COUNTY COUNCIL

EDUCATION COMMITTEE

ENFIELD TECHNICAL COLLEGE, QUEENSWAY, ENFIELD, MIDDX.

LECTURERS

REQUIRED:

1. SENIOR LECTURER IN CIVIL ENGINEERING to teach Theory of Structures and Surveying to Final Diploma standard. Candidates must be University Graduates in Civil Engineering, corporate members of the Institution of Civil Engineers and have had industrial, teaching and/or research experience.

2. LECTURER IN CIVIL ENGINEERING to teach Civil Engineering subjects up to Diploma standard. Candidates must be University Graduates in Civil Engineering and at least Graduate Members of the Institution of Civil Engineers. They should have had industrial and/or teaching experience.

Salary within the range:

Senior Lecturers: £1588-£1801 per annum.

Lecturers: £1408-£1601 per annum.

Application forms (foolscap s.a.e.) from the Principal, to whom completed forms should be returned within 14 days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
SECRETARY TO THE EDUCATION COMMITTEE. B 657

APPOINTMENTS OPEN

ASSISTANT SITE ENGINEER

A young ASSISTANT SITE ENGINEER is required by engineering firm specialising in the design and erection of high pressure steam raising plant. Preferable age would be between 25 and 30. Commencing salary would depend on qualifications and experience and there are good prospects for advancement. An out-working allowance is paid when working on site.—Applicants should forward full details of their education and previous employment to BOX B 545, Offices of ENGINEERING.

TECHNICAL EDITOR

TECHNICAL EDITOR requires assistant for new monthly publication of Fuel Abstracts. Graduate preferred, good background in Engineering or Science essential. Experience in collating, classifying and indexing necessary, typing an advantage. Salary from £900 per annum.—Applications in writing to INSTITUTE OF FUEL, 18, DEVONSHIRE STREET, W.1. B 634

ENGINEER

Fully qualified ENGINEER to be directly responsible to the Partners required by medium-sized firm of Consulting Engineers in Westminster. Should have had varied civil and structural engineering experience including road, bridge and railway works. Age 35-45. —BOX B 577, Offices of ENGINEERING.

MAINTENANCE AND DEVELOPMENT ENGINEER

MAINTENANCE AND DEVELOPMENT ENGINEER required by HAWTHORN LESLIE (SHIP BUILDERS), LTD., HEBBURN UPON TYNE. Sound experience of plant installation and maintenance essential. Applications to General Manager giving age also particulars of training and experience. B 613

PRESS SPECIALIST

PRESS SPECIALIST required for Machine Tool firm in London. Applicants must have first-class knowledge of press tool design over a wide range of presses. The post involves periodic tuition in Companies on the Continent and should be of interest to young engineers who are keen to get off the drawing board. State age, education, apprenticeship, experience, giving details of each employer, present salary and salary required.—BOX B 610, Offices of ENGINEERING.

AEI

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

TURBINE GENERATOR DIVISION

DESIGN and DEVELOPMENT ENGINEERS

A policy of expanding technical development has created a number of vacancies for Design and Development staff in the following departments in the Turbine-Generator Division, Trafford Park, Manchester.

LARGE STEAM TURBINES
SMALL STEAM TURBINES
LARGE GENERATORS
MECHANICAL DEVELOPMENT

Applications are invited from Engineers who are graduates or who possess a Higher National Certificate, and who have had experience in the design of high speed rotating machinery. Previous experience on steam turbines or generators would be an advantage.

There are rewarding opportunities for men with the right qualifications who are prepared to tackle interesting and challenging problems in these fields.

Please write for an appointment giving brief details of qualifications and experience quoting reference Z.14 to:—

THE PERSONNEL MANAGER,
ASSOCIATED ELECTRICAL INDUSTRIES
(MANCHESTER) LTD.,
TRAFFORD PARK, MANCHESTER, 17. B 649

National Research Council Canada

Division of Building Research

Scientific Research Opportunity

The Division of Building Research, National Research Council has an opening for a

CHEMIST or CHEMICAL ENGINEER

to assume responsibility for cement and concrete research in the Division. The research studies will embrace studies on the properties and use of concrete materials in well equipped laboratories located in Ottawa.

Applicants should hold a Master's degree from a recognized university and have from 3 to 5 years' experience in the cement or concrete field.

Salary will depend on education and experience. Applications and requests for further information should be addressed to:

Employment Officer
National Research Council
Ottawa 2, Ontario
Canada

B 567

A LARGE COPPER MINE IN THE

RHODESIAN SELECTION TRUST GROUP

requires a

SENIOR ELECTRICAL ENGINEER

Applicants should hold a degree in Electrical Engineering and have had subsequent experience in heavy engineering work. They should preferably be under 35 years of age.

Duties will consist of planning engineering projects of a varied nature in connection with large scale mining operations including power generation and distribution, mine shafts and haulage, ore treatment, smelting and other associated heavy engineering plant.

Basic starting salary from £1750 p.a. depending on qualifications and experience. There is also a bonus scheme at present paying 33 per cent. on basic pay and a variable cost of living allowance, currently, £65 p.a. The company has generous pension, life assurance and medical schemes and it also operates share purchase and house purchase arrangements.

Leave at 51 days p.a. may be accumulated over three years' service.

The outward passages for the employee and his family would be paid by the company.

Full particulars covering age, qualifications and experience should be sent in confidence to:

The Overseas Personnel Officer,
SELECTION TRUST LIMITED
Mason's Avenue · Coleman Street,
London, E.C.2

Please quote R.7/EG. B 647

ELECTRICAL DESIGN ENGINEER

A Graduate is required for the position of Electrical Design Engineer at this fully integrated Iron and Steel Works situated on the West Coast of Cumberland. The work is extremely varied ranging from High Voltage Power to Control Engineering.

Good Life Assurance and Contributory Pension Scheme.

Applicants, who should have had practical experience subsequent to a recognised training scheme, should write to

The Secretary,
WORKINGTON IRON & STEEL COMPANY,
(a Branch of The United Steel Companies Limited),
MOSS BAY, WORKINGTON, CUMBERLAND.

B 597

DESIGN STAFF

required by the

UNITED KINGDOM ATOMIC ENERGY AUTHORITY, PRODUCTION GROUP,

for the Fuel Element Inspectorate Design Office.

This Inspectorate is responsible for the detailed design and inspection of Fuel Elements manufactured at the Authority's Springfield Works for the National Nuclear Power Programme, for export reactors and for the Authority's own reactors. At present the Inspectorate is located at Risley, near Warrington, Lancs., but it is possible that in 18 months to 2 years time it will be transferred to Springfields Works, Salwick, Nr. Preston, Lancs.

DUTIES: To lead teams of Assistant Design Engineers and Draughtsmen engaged in the design of fuel elements.

The duties will include the assessment of preliminary designs prepared by reactor designers and the development of production designs to meet the requirements for economic manufacture and extreme reliability in service.

The design teams will be responsible for preparation of manufacturing drawings and technical specifications for fuel elements and their components, and also, in co-operation with Commercial Directorate, for the programming and ordering of fuel element components to meet the Authority's manufacturing programme.

QUALIFICATIONS AND EXPERIENCE: Applicants must have served a recognised engineering apprenticeship and be corporate members of a Senior Engineering Institution, or hold equivalent qualifications, and have had considerable design experience in precision work for batch production. Shop experience in this field in tool-making would be an advantage.

SALARY: Within the ranges £1370-£1825 and £1880-£2180 according to qualifications and experience.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form, quoting reference P.137/J2, to Staff Officer, United Kingdom Atomic Energy Authority, Production Group Headquarters, Risley, Warrington, Lancs.

Closing Date: 31st March, 1960.

B 602

RICHARD THOMAS & BALDWINS LIMITED

TECHNICAL STAFF

FUEL ENGINEERS

Fuel Engineers are required to be based at the Company Central Engineering Department, Spencer Works, Llanwern, Newport, Mon., for work in connection with new projects at the Company's Works, but particularly with the new fully integrated works under construction at Llanwern. Applicants must have extensive experience of fuel technology as applied to iron and steel production, with particular reference to gas distribution control, steam production and distribution, and to furnace practice. A sound technical education is required.

INSTRUMENTATION ENGINEERS

Instrumentation Engineers are required in the Company Central Engineering Department mentioned above, for work in connection with preparation of, and supervision of installation of instrumentation schemes at the Company's works, in particular at the new Spencer Works at Llanwern, near Newport, Mon.

Applicants should be thoroughly familiar with the application of modern techniques and equipment to iron and steel production processes.

Salary scales commensurate with qualifications and experience.

Contributory Staff Pension and Life Assurance Scheme.

Applications in confidence, should be addressed to—

"The General Manager—Engineering, Company Central Engineering Department, Spencer Works, Richard Thomas & Baldwins Limited, Llanwern, Newport, Mon."

the envelope to be endorsed "Fuel Engineer" or "Instrumentation Engineer" as appropriate, in top left-hand corner. B 626

TECHNICAL WRITER

£725—£800

per annum to commence according to age and experience.

TECHNICAL ILLUSTRATOR

a progressive light engineering group in mid-Warwickshire wish to make these appointments to complete a small team engaged in the preparation of maintenance and workshop manuals covering their automotive and aircraft products.

Salaries reviewed annually. Profit Sharing and Pension Schemes. Extensive sports and social facilities.

Saturday morning or evening interviews may be arranged on request. Please submit details of age and career to date to BOX B 639, Offices of ENGINEERING.

G.K.N. (S.W.) LTD.

have a vacancy for an

ASSISTANT FUEL TECHNOLOGIST

Experience essential in re-heating/annealing furnaces, steam raising and protective atmosphere plant, and plant using oil and gaseous fuels. Knowledge of instrumentation and of automatic control is also essential.

Permanent superannuated position.

Write for application form to Personnel Manager.

GUEST KEEN AND NETTLEFOLDS (South Wales) LTD.
CARDIFF B 661

DRAUGHTSMAN

DRAUGHTSMAN required for work on valve design. Good working conditions, pension scheme, etc. All applications will be treated in confidence.—Apply in writing to CHIEF ENGINEER, ALLEY & MacLELLAN, LTD., BROMYARD ROAD, WORCESTER, quoting reference number. B 621

ASSISTANT ENGINEER

ASSISTANT ENGINEER for work in connection with site investigations and soil mechanics laboratory required immediately by CONSULTING ENGINEERS, F. R. BULLEN & PARTNERS, DACRE HOUSE, DEAN FARRAR STREET, LONDON, S.W.1. B 620

DRAUGHTSMAN

Modern Paper Mill in the South of England requires ENGINEERING DRAUGHTSMAN. O.N.C. standard. Capable of plant layout and piping arrangements. Ability to work with minimum supervision. Non-contributory pension scheme. Canteen facilities.—Full particulars to BOX B 631, Offices of ENGINEERING.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

CONSTRUCTION AND PLANNING ENGINEERS

The Construction Branch of the Development and Engineering Group is responsible for carrying out a varied programme of interesting work on large scale construction sites throughout the country. There are vacancies for civil, mechanical and electrical engineers who have had experience of construction site work and are willing to move from site to site as required. There is also a vacancy at Risley for an engineer to work in the Planning Section on the co-ordination of design, supply and construction.

Applicants must have served a recognised engineering apprenticeship or pupilage and be corporate members of a senior engineering institution or equivalent.

Salary between £860 (at age 25) and £1340.

Contributory superannuation. Staff housing scheme.

Send postcard for application form, quoting reference 203/J.2, to Recruitment Officer, U.K.A.E.A. (D and E Group), Risley, Warrington, Lancashire, before 4th April, 1960. B 604

APPOINTMENTS WANTED

EXPERIENCED STAFF AVAILABLE

EXPERIENCED STAFF for hire in all branches of engineering.—Please phone AMB 8189. B 591

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d.
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SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Higher Research Costs and Lower Margins

Mounting research costs, power stations increasing in size and diminishing in numbers, intensification of overseas competition, these are the conditions that set the background to the annual statement of Lord Nelson, the ENGLISH ELECTRIC Company chairman.

The group last year had an increase of just over £400,000 in its trading account balance to a total of £11,445,372. For the fifth year the percentage of group profit to turnover fell, the increase in earnings coming from a larger share of the market being obtained, though at reduced profit margins.

On this point Lord Nelson said "Our volume of business continues to rise, and during 1959 we took orders to a value of £14 million higher than we did in 1958; but prices are much keener and profit margins are much lower than is healthy for this type of business.

Disappointing

"Export orders are secured only at prices so disappointingly low as to fail to provide adequate margins which are essential to cover large scale expenditure on research and development."

The reduced prospects in the number of power stations to be built in Britain has led to a recasting of the organisation of the private nuclear industry and the number of consortia has fallen from five to three. The consortium in which English Electric is involved—ENGLISH ELECTRIC-BABCOCK and WILCOX-TAYLOR WOODROW—continues in its original form. The consortium is currently engaged on the Hinkley Point nuclear power station.

For marine reactors, English Electric is associated with the NORTH AMERICAN AVIATION company.

Looking beyond the modernisation programme of British Railways, Lord Nelson foresees the time when the diesel and electric locomotives of English Electric will have to be sold overseas if they are to be sold at all. For the next three or four years there will still be a considerable British Railways demand.

Development

The heavy investment in research and development of the MARCONI WIRELESS TELEGRAPH Company and the severe foreign competition have taken their toll of profits. But the chairman is able to report increased turnover and the heaviest order book since 1951.

Among the fields in which Lord Nelson reported very significant technical progress were ground radar for defence and air traffic control, radar data handling, mobile radar navigational aids and other applications for similar devices.

The year set a new record in the number of radio and television stations brought to transmission point. Late in the year, Ghana ordered a £500,000 high power sound broadcasting station. NATO ordered a £7 million early warning radar chain and an order worth £1½ million, for an advanced radar data handling system, came from Sweden.

Despite the discouraging conditions in shipping, the MARCONI INTERNATIONAL MARINE COMMUNICATION Company still showed a £500,000 profit. Mainly due to "excessive manufacturing costs" in the first production of two new aircraft engines, the D. NAPIER AND SON aviation company ended the year with a trading loss of £1,200,000.

More cheerfully, Lord Nelson was able to list some of the overseas markets for which the locomotives of the ENGLISH ELECTRIC GROUP were either delivered to or in production. They included Argentina, East Africa, Ghana, India, South Africa, the Sudan, and Poland (in association with Associated Electrical Industries).

Diesel or Steam or Nuclear

The German marine engines industry currently presents a lively scene of three methods of propulsion contending against each other. They are steam turbines, diesel engines and forms of nuclear energy.

Among firms specialising in marine propulsion engines are BORSIG of Berlin, KLOCKNER-HUMBOLDT-DEUTZ of Cologne, KRUPP of Essen, MAK of Kiel, and MAN of Augsburg. Intense rivalry is reported between steam turbines and diesel engines. The large tankers and bulk carriers favour steam turbines. It has been estimated that some 61 per cent of the world's merchant fleet is now equipped with steam engines and 39 per cent with diesels. Less than 7 per cent of vessels now operating are using coal fired engines. Diesel engines of 20,000 h.p. and over are now being built by MAN and engines of this type are being increasingly used in tankers.

Four German shipyards are engaged in research and development projects in connection with the use of nuclear energy in marine propulsion. These are:

(1) Gesellschaft führ Energieverwertung in Schiffbau und Schiffahrt at Hamburg, which is a research body supported by the West German Government, some of the Land governments and the shipping and shipbuilding industry;

(2) AG Weser in collaboration with Friedrich Krupp of Essen and BROWN BOVERI and Company of Mannheim;

(3) Deutsche Werft in collaboration with AEG of Frankfurt and General Electric; and

(4) Howaldt of Hamburg in collaboration with Siemens of Erlangen.

The Howaldt-Siemens group is concentrating on the possible use of a pressurised-water reactor of the type used in the Soviet icebreaker Lenin. AG Weser and Brown Boveri are working on a gas-cooled reactor.

Another new development is the study of the technical problems involved in the transport of liquefied methane. The idea is to bring gas from the Saharan field to Germany. The big problems to be overcome concern the low temperatures involved.

Spades and Hoes Doing Well Abroad

A nine per cent increase in output over the previous year and export sales accounting for 60 per cent of their production were reported by Mr. H. W. Hunt, chairman of EDGE TOOL INDUSTRIES, in his annual statement.

Apart from Indonesia, which issued no import licences during the year, overseas markets showed an improving demand for the hoes produced by the CHILLINGTON TOOL subsidiary. Both at home and abroad the Wednesbury subsidiary, EDWARD ELWELL Limited, had a better year with forks and shovels and its export "leaders" were its axes and hatchets.

The group's Brazilian subsidiary, FABRICA DE ARTEFATOS DE ACO TUPY S.A., also had a good year but trading operations have been very restricted by the drought in Northern Brazil in the current year. Profits have been much reduced by "the high cost of compensation to employees who had of necessity to be dismissed."

RTB Promotions and New Plant

RICHARD THOMAS AND BALDWIN'S £110 million Spencer works at Llanwern, near Newport, South Wales, is the eye catching symbol of the company's maintenance of its traditional place in the van of the iron and steel industry.

Equally significant are two other developments, one in plant and the other in people.

At the relatively humble cost of £7,688,000 RTB are putting in another electrolytic tinning line, additional soaking pits and an acid recovery plant and installing the LD process at their Ebbw Vale works.

In his annual statement, the new chairman, Mr. G. C. R. Eley, referred to the election to the board of four senior executives. They are Mr. Campbell Adamson, general manager of the Spencer works, Mr. William L. Cave, controller of sales, Mr. William F. Gilbertson, controller of production, and Mr. G. Lloyd Jones, chief accountant. Mr. Eley observed that their appointment was not merely a recognition of their personal merits but a tribute to all the executives and a means of achieving an even closer relationship between the management and the board.

The firm of Richard Thomas have a long history of technical leadership. The stimulus to their staff of the four senior executives' promotion to the board should be invaluable and the step is itself an example to others.

The Spencer works, named after the Richard Thomas managing director, Mr. Henry F. Spencer (inset), is being installed on an accelerated programme that should bring it into production by April, 1962, a full year ahead of the original schedule. Permission has also been granted by the Iron and Steel Board for an output of 1,400,000 ingot tons instead of the first target of 1,073,000 tons. The site chosen for the Spencer works allows for considerable further expansion and the first stage could without great difficulty be expanded to an annual production of 3,000,000 ingot tons.

The Ministry of Power £70 million loan towards the cost of the project, which is due to be repaid by 1971, is the centre of a parliamentary engagement, with Labour members and the Conservative right objecting for different reasons to this method of financing the steel industry's new capacity.

Unexpected

That Richard Thomas were able to increase their profits last year by a quarter, while engaged in such an immense building and rebuilding programme, including the unexpected need to rebuild the roof of the Bessemer Shop at Ebbw Vale, is an obvious pointer to the future achievements of the company when less of its energies are involved with building up programmes.

For the next decade, once the Spencer works is operating to the full, Richard Thomas will be carrying much increased interest and depreciation charges. Its new output will be making a higher level of industrial activity possible in the United Kingdom and at the same time, with the Government loan to be repaid and the immense new plant to be kept fully occupied, the company will be dependent on a very high degree of output by all its customers.

What Next at BMW?

Although the German motor industry is doing very well just now one of its oldest companies is in difficulties. This is BMW, the Bayerische Motoren AG, of Munich, a firm which suffered severely as a result of the war. Its main plant at Eisenach is now in East Germany, factories in Berlin and Munich were dismantled and a third, at Munich, was requisitioned up to 1950. Immediately after the war BMW started making motor cycles and only turned to cars in 1952. Motor cycle production which was around 28,000 units in 1952 has now dropped to about 7,000 a year. And BMW cars, big high powered saloons and expensive sports cars, have been rather highly priced for the German public.

The banks, especially the Deutsche Bank which is a major shareholder, began to get worried and press for a reorganisation. Plans for this which would have involved BMW's being merged into Daimler-Benz were turned down at a somewhat noisy shareholders' meeting last December. Since then, several possible solutions have been mooted. One is that the Bavarian Government would help by putting up a considerable loan. A second is that some new approach might be made to Daimler-Benz that would be more favourable to BMW shareholders. This solution has not been welcomed by Daimler-Benz which is now expanding its Auto-Union affiliate which makes the small DKW cars. The third prospect is that MAN might buy the BMW Triebwerksbau plant which has hopes of landing a substantial contract for jet engines from the West German defence ministry. Finally, there is the prospect that a foreign firm, and the Rootes Group is among those suggested, might make a bid. Not surprisingly, although the future position is obscure, the outlook for BMW shareholders is brighter. With so many possibilities in the offing shares have shot up again.

By Casting Plastics: Rollers Improved

Composition inking rollers on printing machines are affected by temperature and humidity. A new roller overcomes these troubles.

Sensitivity to temperature and humidity changes are inherent in printing rollers of the normal composition type, and to obviate the difficulties arising from this characteristic a range of rollers made of polyurethane has been introduced by the Avon India Rubber Company Limited, Melksham, Wiltshire. Polyurethane has all the properties required for good ink distribution, combined with size and hardness stability under all reasonable temperature and humidity conditions. Rollers are now in production for all normal types of printing machine, and Avon undertake both the covering of new spindles and the stripping and recovering of used ones.

Poly-U is produced by the chemical reaction of a polyester with di-isocyanate. Polyesters cause no difficulties in use, but di-isocyanate is extremely reactive with water, and in addition it is poisonous. Special methods have, therefore to be employed for handling the di-isocyanate and for carrying out the mixing.

On receipt by Avon, roller spindles are stripped of their previous covering and those which are of hollow construction are tested to ensure that they will not leak air when heated to the temperature used for curing. Such air, of course, would cause bubbles in the poly-U and thus give faulty rollers. Spindles are next degreased in an ICI trichlorethylene vapour tank and shot blasted in a Tilghman single nozzle cabinet, modified to rotate and traverse the spindle under the nozzle. They are then washed in carbon tetrachloride to ensure complete cleanliness.

Both the ingredients of the poly-U, polyester and di-isocyanate are received in 40 gallon steel drums, and both are raised by means of compressed air pumps to overhead storage tanks. Polyester is handled without difficulty, but di-isocyanate, if there should be any moisture present, is liable to interfere with the operation of the pipeline valves. In practice it has been found that Saunders diaphragm valves, with ptfe diaphragms, are completely satisfactory for controlling both materials.

As polyester is a very viscous liquid at room temperature, the storage tank is maintained at a moderate temperature so that when required the liquid will flow from the tank without undue delay. As both materials are fed from storage by gravity the tanks have to be vented, and in order to prevent moisture entering through the vent into the di-isocyanate tank a moisture trap is incorporated.

Mixing takes place in a jacketed vacuum mixer below the storage tanks, glass measuring vessels enabling the correct quantities of each ingredient to be admitted. The measuring vessel for the polyester is of fixed capacity, while that for the di-isocyanate is graduated, to allow the proportions of the mixture to be varied according to the desired hardness of the finished rollers. A mixture of about nine parts of polyester to one part of di-isocyanate is usual.

An anchor-type paddle is incorporated in the mixing vessel and polyester is admitted first and sealed for a period under high vacuum and temperature in order to dehydrate it completely. Subsequently the polyester is cooled to approximately 75° C when the di-isocyanate is added, after which the mixture is stirred under vacuum for a further period until the reaction between the polyester and di-isocyanate is complete. At the end of this mixing period the resultant liquid is discharged into a holding vessel.

Meanwhile, the moulds have been prepared. Moulding is carried out in two ways; in trunnion mounted jacketed moulds for large rollers (over 3 ft long) and in moulds grouped in fours and mounted on a common plate for small rollers (from about 19 in to 3 ft). The moulds for the large rollers are of seamless steel tube, bored inside and honed to a mirror finish, and have a welded jacket for steam heating and water cooling. As isocyanates are excellent bonding agents to metal it is necessary to coat the mould surface with a dope which will prevent polyester adhering to the metal. This is carried out by mopping the mould surface in a manner similar to cleaning a gun barrel.

Phosphor-bronze plug ends are fitted to the moulds to locate the spindle concentrically with the mould wall, and to seal the bottom end. Subsequent to doping and fitting of the bottom plug, the mould is cooled with water to a suitable temperature for pouring.

The mixed material is poured into the moulds from a holding vessel and a stand period is then allowed for the escape of air bubbles, after which steam is admitted to raise the temperature above 100° C, which will cause cross-linking to take place in the material and provide a polyester of the desired hardness. When the cure is complete, a process which takes approximately two hours, the steam is turned off and the roller is ready for extraction from the mould. This calls for a very smooth and steady movement, and it is done by means of a 1 ton Clayton electric hoist block fitted with creep control.

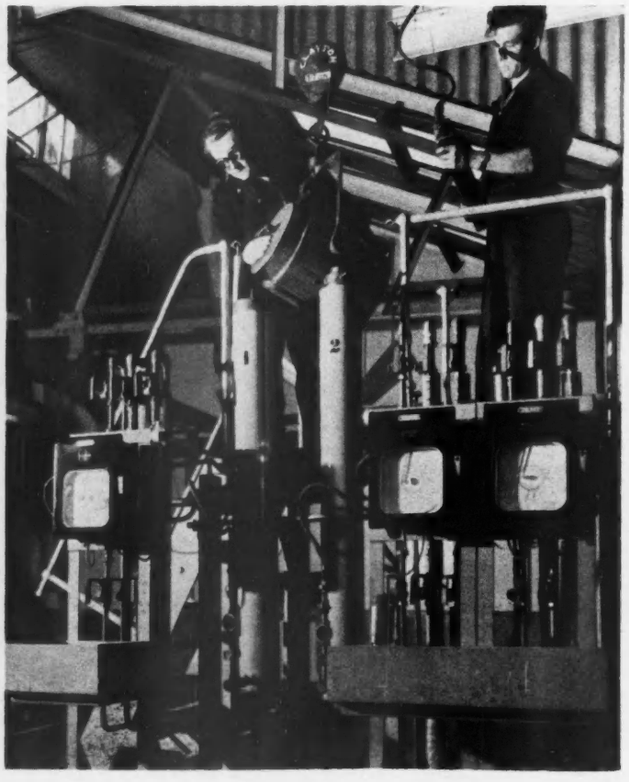
The ends of the roller are trimmed square in a lathe, and after final cleaning of the roller surface it is placed in a holding bay ready for inspection. Visual examination ensures that the poly-U is free from bubbles; as it is a light-coloured translucent material any defects of this kind would be immediately apparent. Finally, a check is made for concentricity over the whole length of the roller. All rollers are guaranteed to be concentric with the spindle to within $\pm 0{\cdot}005$ in.

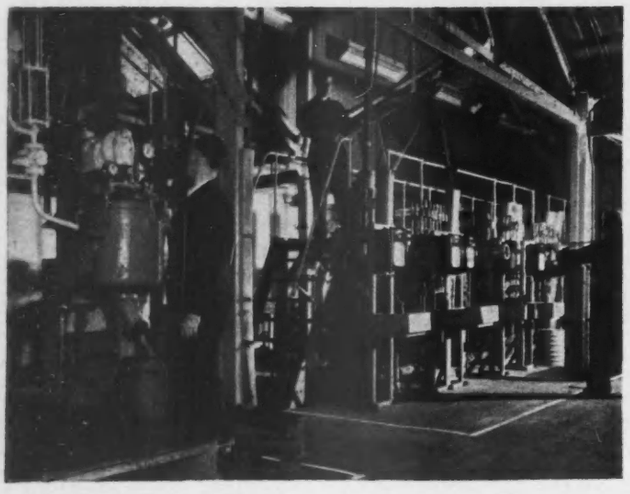
Production of smaller rollers differs from that of the larger ones only in the method of curing. Unjacketed moulds grouped in fours are used for convenience of handling and curing is carried out in an electric hot air oven which must be thermostatically controlled within very narrow limits in order to provide a satisfactory roller. Extraction of the roller after casting and curing is by means of a specially long pneumatic cylinder and piston, which has creep control and pushes the roller out of the mould at the steady rate required. End trimming and inspection follow, as with the larger rollers.

As the mould surface becomes scaled with continual use mould cleaning becomes necessary and this is performed with the aid of hot caustic soda solution. Maintenance of other plant calls for no special arrangements, except in the case of the containers, pipelines and valves for di-isocyanate. Any repair work to be done on this equipment is carried out by workers wearing protective clothing.

(Right) Casting is done from a special vessel suspended from an electric hoist. The hoist is also used to extract the finished rollers from the moulds.

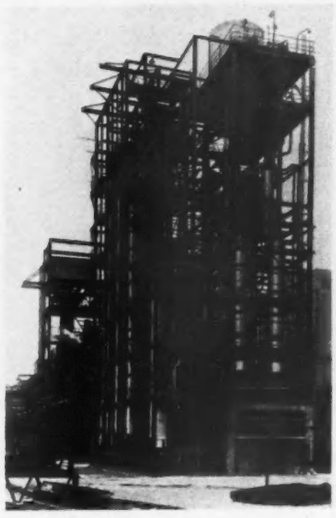
(Below) Printing rollers are coated with polyurethane mixed in the vacuum vessel on the left, and cast into the moulds seen in the background.





Fully Continuous Benzol Fractionation

A new continuous benzol refining plant, designed and constructed by the chemical engineering division of the APV Company Limited, has been put on stream at the Scunthorpe Coke Oven and Chemical Plant of the Appleby-Frodingham Steel Company. This plant is the first in Britain to produce nitration grade boiling range benzol and toluol, 2° xylol and 160/190° naphtha



The new benzol refinery.

continuously from crude coke oven benzol. The design throughput is 5½ million gallons a year. The operation of five continuous fractionating columns in series is reported to represent a striking advance in the benzol refining field.

In a test run, it was established that, at a throughput rate of over 650 gallons per hour of crude benzol, the refinery produced the above products with a steam consumption of less than 11·8 lb per gallon of crude. Subsequent operation shows a considerable reduction in this figure.

The refinery incorporates a new APV continuous defronting unit which is capable of producing defronted benzol containing as little as one part in a million of carbon disulphide sulphur with a very low loss of benzene in the overhead fronts.

Work Loading Chart

New Industrial Charting and Publicity Limited of Edinburgh have produced a work loading or programming chart, called the "See-How," which is claimed to have several unique advantages over other similar charts. It falls into the category of what is called a Gantt chart. Such a chart consists of a number of horizontal rows, one for each machine, process or man to be loaded or stage of manufacture to be programmed. The horizontal length along the row represents time in hours, days or weeks. A machine, for example, is loaded by marking off lengths of a row corresponding to the estimated time to do the jobs allocated to the machine, and in a position corresponding to the time of day or week at which the jobs will start and finish.

In the majority of industries, each part or job passes through a number of machines. Because of the different times taken to do different jobs and the different sequences of machines used, it is seldom possible to load every machine fully, and the problem becomes one of achieving the most efficient loading consistent with satisfying a number of conditions such as delivery dates and full utilisation of expensive machinery. The charts help to solve this problem.

The chart consists of a rigid base board on to which is printed column and row headings and a fine network of orthogonal lines similar to graph paper. This is covered by a transparent sheet, The times of jobs are represented by lengths of a special self-adhesive tape with a clean edge, which enables the tape to be removed and reattached many times without damaging the tape. The tapes are supplied on ruled sheets, and all the relevant information about any one job can be typed on to the tape before they are cut to length and stuck on to the chart. The tapes are available in a wide range of colours.

Before the job tapes are loaded on to the chart, each row is covered by a red tape. The job tapes are then mounted on this red tape, so that after loading, unloaded portions show up in red. The red tape base allows rapid rescheduling to be carried out if a machine, for example, breaks down. The tape can be cut at the point of breakdown and the remainder of the row moved forward by moving along the red tape to which all the other job tapes are fixed.

Multispindle Drill Head for India

The accompanying illustration shows a part of a shipment recently made by W. J. Meddings Limited and sent to Messrs. Enfield India Limited. The adjustable multi-spindle head is to be used for the production of four different component parts of an auto-cycle.

By using interchangeable spindle cluster

Multi-spindle drilling equipment for Indian auto-cycle production.

plates, different patterns can be accommodated in the same basic head casting. This means that after producing say 500 of one part, a new spindle cluster plate with a different hole pattern is fixed into the head, and by using the mating bushplate, and by effecting a simple change of location, a new component can be machined after a relatively quick changeover. Although fixed centre multi-spindle heads are generally more desirable, this method of construction does allow for rather shorter tuns to be accommodated by using adjustable centre spindles, with the added advantage that any one particular hole pattern can be repeated accurately by using the jigbored cluster plates already referred to.

Protection During Welding Operations

Following the recent publication of BS 679, "Filters for use during welding," the British Standards Institution has now issued a revision of BS 1542. Thus, two associated standards dealing with head protection against welding radiation are now brought up to date.

BS 1542 takes account of the new welding processes requiring greater protection than previously found necessary, and it recommends equipment for use with classified types of welding. Requirements for quality of workmanship and finish for spectacles, goggles, masks and helmets are specified, and their tests for flammability, strength of spectacle frames, and for corrosion resistance. There is a new test for electrical resistance. The marking requirements now call for the application of BSI's certification mark.

Progress at Hunterston

Following the full resumption of operations on the Hunterston site, an encouraging start has been made towards achieving a higher production rate on the pressure vessel construction and other steel fabrication that has been held up for so long. One of the first achievements was the successful turning over and lifting into the biological shield of the complete bottom head and support course of the 3 in thick steel pressure vessel for reactor A. This has been followed by the 70 ft diameter third course.

The lifting of the bottom head and support as a single unit demonstrated not only the lifting capacity of the Goliath crane, but also the precision of its control. The unit, with its lifting beams, weighs 320 tons, and has an overall diameter of 66 ft. Welded on the outside, on a pitch-circle diameter of 62 ft, are 120 slotted gusset plates, and the unit had to be positioned so that these slots would fit smoothly over the outer skirt which was already in position inside the reactor vault. Only $\frac{1}{32}$ in clearance was available in each slot.

The bottom head had been welded in an inverted position on the special prefabrication area between the steam raising unit fabrication workshop and reactor B. It had then to be lifted on to the completed support course, the two welded together, the gusset plates attached and the slots accurately cut. Most of this had been done when work was suspended last September. Very shortly after work on this part had been started again, the complete unit was turned by the crane. A few days later, when weather conditions were suitable, it was lifted by the crane, carried over the partly finished structure of reactor B, and lowered into place on the outer skirt inside the biological shield of reactor A.

Welding of the gussets to the outer skirt was

The 320 ton bottom head and support course being lowered into the reactor A vault.

then begun, and following completion of this, the next course, was lifted into position.

The success of these operations is an indication of the efforts being made to make up for some of the time lost last year. Over 500 men are now working three shifts for the Motherwell Bridge and Engineering Company. The main contractor for the power station is the General Electric Company Limited of England: a member of the GEC—Simon-Carves Atomic Energy Group.

Greases to Prevent Fretting Corrosion

Fretting corrosion is an imperfectly understood phenomenon at present, but enough is known about it to enable its effects to be minimised.

By N. A. Scarlett

Shell Research Limited, Thornton

Fretting corrosion (also called friction-oxidation, chafing corrosion, or false Brinelling) is a term used by Tomlinson[1] to describe the type of surface damage which occurs at the interfaces of closely fitting machine components when subjected to vibrations or reciprocal oscillations. This phenomenon differs from ordinary wear between sliding surfaces in that fretting usually occurs at contact surfaces that are not intended normally to move relative to one another, such as spline shafts (Fig. 1) and between fixed parts of rolling bearings which are a press fit on their seatings. It also occurs in universal couplings and in certain instances between the rolling elements and raceways of rolling bearings (Fig. 2) when subjected to vibration while otherwise stationary. This latter damage is usually referred to as false Brinelling, and commonly occurs during transport of machinery. Replacement of components damaged by fretting corrosin is an expensive item.

Fretting corrosion produces irregular corroded and pitted areas and when one of the contacting surfaces is a ferrous metal, it is always accompanied by oxide detritus, which gives a characteristic cocoa-like residue. This reddish debris has been identified as a ferric oxide (α Fe_2O_3), which acts as an abrasive at the interfaces. The oxide differs from the one normally associated with moisture corrosion (rusting), which is Fe_3O_4; the two oxides are readily distinguished by X-ray diffraction.

No complete agreement has been reached on the detailed mechanism by which fretting corrosion occurs. However, certain facts have been established which may be summarised as follows:

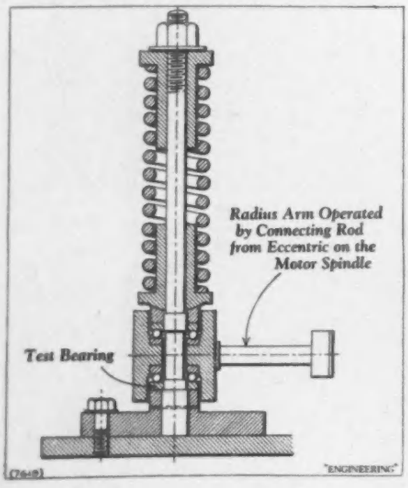
(1) Alternating slip of small dimensions is the principal cause of fretting corrosion.

(2) Fretting can occur between materials which are not readily oxidised, e.g. platinum and glass.

(3) Fretting damage is less between dissimilar than between similar materials (stainless steel is particularly prone in any combination).

(4) Damage due to fretting may be minimised in the following ways.

(*a*) By eliminating the cause, e.g. by avoiding vibration or preventing mutual slipping as by bonding the surfaces by means of a plastic or elastic material.
(*b*) In the case of oxidisable materials by excluding oxygen from the contacting areas.
(*c*) By the use of high humidities.
(*d*) By the use of lubricants.



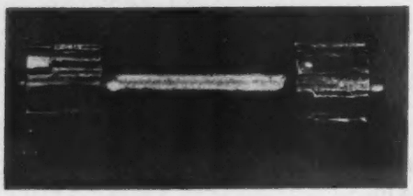


Fig. 1 Fretting corrosion on spline shaft.

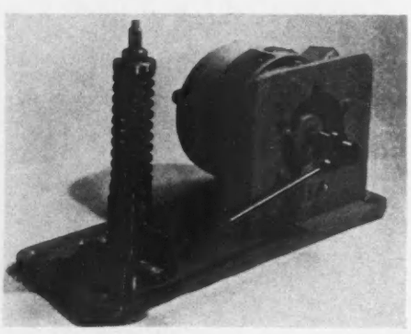
It is the last method of reducing fretting that is of particular concern to makers of lubricants. Little attention had been given in the published literature to the properties of lubricants that might mitigate fretting when the present work began in 1950. As a first objective the work aimed at assessing the anti-fretting properties of greases recommended for conditions where fretting was likely. This aspect of the work forms the main subject of the present study; the effect of compositions and physical variables on anti-fretting properties is briefly referred to and is still under investigation at present. More recently two papers[6,7]; have been published in the USA on the part played by lubricants in fretting corrosion, and the results are considered more fully later in this report.

EXPERIMENTAL WORK

After examination of the available literature on the limited number of test rigs that have been employed for investigating the effects of fretting corrosion, it was clear that a rig developed by the Fafnir Bearing Company and referred to as the " friction oxidation " rig, would be the most suitable for the purpose in view. This rig, which is simple in construction and operation, employs ball thrust bearings for test pieces, the assembly being as shown in Fig. 3.

For the current investigation the housing in which the thrust bearings were mounted was oscillated through an angle of 6° at 1,420 cycles per min by means of a connecting rod coupled to an electric motor (Fig. 4). A load of 600 lb (the rated static capacity of the bearing is 4,500 lb) was applied to the bearings (through a spherical seating to aid distribution) by a calibrated spring held in compression by centralising collars and a nut. To ensure a constant load, the spring compression was checked at frequent intervals and any alteration caused by bearing wear corrected. No heat was applied to the assembly and the normal operating temperature, measured on the outer housing, was a few degrees above ambient.

The test bearings were thoroughly cleaned by



Figs. 3 and 4 General arrangement of Fafnir friction-oxidation rig used at Thornton.

Fig. 2 Fretting corrosion or false Brinelling on roller bearing raceways, caused by stationary vibration.

washing in light petroleum (60° to 80°), weighed and charged with 1½ gm of the test grease. The test was run continuously for 50 or 1,000 hours and the rig then dismantled for the test bearings to be examined, cleaned and reweighed. It was observed that the wear of the two races of the test bearing was not always proportional to the total wear of the bearing. This was attributed to variations in cage wear which in turn can be caused by inaccuracies in the pressed steel cages. As a third component comparable to the cage of the ball bearing is not present in many applications, e.g. spline shafts and couplings, the wear on the races was therefore considered alone. Loss in weight due to wear of the races was taken as the criterion of the lubricant's failure to retard fretting corrosion, and this rating agreed fairly closely with the visible evidence.

When the race wear was greater than 2 mg the contact areas on the races invariably showed red discoloration consistent with oxidation of the metal, the amount of discoloration becoming greater as the amount of wear increased. When fretting was severe, the grease, too, was discoloured red.

Preliminary tests showed that the top race of the upper bearing (which must be a sliding fit on the spindle to ensure that the full load is applied) tended to creep slightly, thus distributing the wear over a greater arc than intended. Test observations were therefore confined to the lower bearing.

A test was carried out to ascertain the severity of fretting corrosion in the Fafnir appratus when no lubricant was applied to the bearing. In a period of only 5 hours, severe fretting corrosion occurred. The wear was about the same as that subsequently observed with the worst grease when tested over a period of 50 hours, and an appreciable amount of ferric oxide was present (Fig. 5).

All the greases were examined over the standard test period of 50 hours and the results are presented in Table 1. At low levels of wear (about 1 mg) the bare figures do not distinguish satisfactorily between greases. Thus, of two greases both giving less than 1 mg wear after 50 hours, one gave a perceptible scar, whereas the other did not, even when the test period was extended to 1,000 hours. Therefore a number of the best greases (less than 1 mg wear) have also

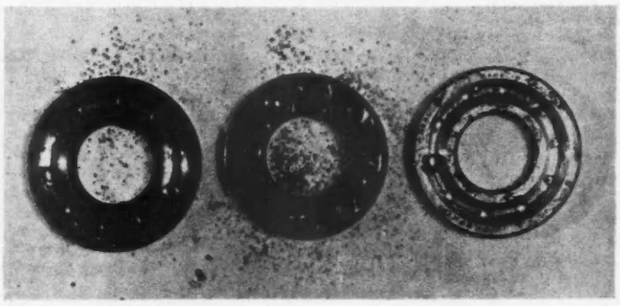


Fig. 5 Condition of bearing after 5-hour test with no lubricant. The powder-like residue is ferric oxide.

been subjected to a 1,000 hours test in order to obtain a better assessment of their antifretting properties. These results are also included in Table 1.

Data showing the influence of mechanical stability and soap content of greases on anti-fretting properties are presented in Tables 2 and 3.

CONCLUSIONS

Performance of Greases.—Of the many greases examined, most displayed only poor or moderate anti-fretting properties. Grease A1, a lithium base grease which contains non-E.P. polar additives, was satisfactory in combating fretting corrosion. Thus, even after a 1,000 hours test ($85{\cdot}2 + 10^6$ cycles), there was negligible wear on the races and the contact areas showed only light polishing. Grease F1, a calcium based grease containing E.P. additives, was also good, but this grease can only be used over a limited temperature range, say $-5°$ C to $+50°$ C and is restricted to the lubrication of all-steel surfaces, because the E.P. additive present tends to attack yellow metals under fretting conditions. In any case, this type of grease is no longer available.

TABLE I.—*Fafnir Rig Tests*

Bearings: All steel. Load: 600 lb. 6° oscillation at 1,420 cycles per min

Grease ref.	Soap type	Oil viscosity Red I at 140° F (sec)	I.P. Pen. worked approx.	Anti-wear additives	Total race wear (mg)	
					50 hr test	1,000 hr test
A	Li	170	265/295	None	<1	1, 2
A1	,,	170	265/295	Polar non-E.P.	<1	<1
A2	,,	170	265/295	E.P. type 1	<1	2, 3
B	,,	170	235	None	3	—
B1	,,	170	235	E.P. type 1	<1	2, 3
C	Ca	90	310/340	None	<1	—
D	,,	170	220/250	,,	2	—
E	,,	90	130/145	,,	62	—
F	,,	350	265/295	,,	<1	1
F1	,,	350	265/295	E.P. type 2	<1	<1
F2	,,	350	265/295	Grease F1 + 10% MoS_2	40	—
G	Al (4·5%)	1,100	350	None	<1	1, 2
H	Al (6%)	1,100	265/350	,,	8	—
I	Al (10·5%)	1,100	270/300	None	40	—
I1	,,	1,100	270/300	Grease I + 10% MoS_2	30	—
I2	,,	1,100	270/300	Grease I + 30% MoS_2	70	—
J	Na	400	300	None	152	—
J1	,,	400	300	Grease J + 10% MoS_2	66, 93	—
K	,,	60	225	None	4	—
L	Li/Na	65	260/310	,,	<1	—
L1	,,	65	260/310	Grease L + 5% graphite	3	—
L2	,,	65	260/310	Grease L + 10% MoS_2	2, 3	—
M	Na/Ca	65	265/295	Not known	3	—
N	Not known	No known	298	Zinc oxide	1	—
O	,,	,,	309	,, ,,	2	—
P	Nil	—	295	52% MoS_2/petrolatum	23	—
Q	Li	160	300	50% MoS_2	42	—
R	Na	70	225	65% MoS_2	60	—
S	Sr	520	286	Not known	81	—
T	Li	65	260/310	5% graphite	3	—
U	,,	45	275	None	4	—
V	Ca	90	265/295	,,	<1	—

TABLE II.—*Mechanical Stability (100,000 Strokes on ASTM Mechanical Worker) and Its Effect on Anti-Fretting Properties of Greases*

Grease Reference	Fafnir Rig Tests		
	Total Race Wear at 50 hr (mg)	IP Worked Penetration (60 Strokes)	Increase in Penetration after 100,000 Strokes Working
A	<1	275	40
F1	<1	290	40
B	3	235	30
K	4	225	20
U	4	275	>325
J	152	300	35
XX	<1	290	70
YY	2	260	90

Greases XX and YY based on ester oil and not included in Table I.

TABLE III.—*Effects of Consistency and Soap Content on Anti-Fretting Properties with the Same Base Grease*

Grease Ref.	Soap Base, per cent approx.	IP Worked Pen, approx.	Oil Viscosity Red I at 140°F (sec)	Total Race Wear on 50 hr Fafnir Rig Test (mg)
C	Ca 12	310/340	90	<1
V	Ca 15	265/295	90	<1
E	Ca 33	130/145	90	62
G	Al 4·5	350	1,100	<1
H	Al 6	265/295	1,100	8
I	Al 10·5	270/300	1,100	40

Fafnir Rig Test and Service Data.—Laboratory test results should by related to field performance ratings of the materials. After the initial discovery on the Fafnir rig that grease F1 had outstanding anti-fretting properties, this grease was tried in a limited number of industrial and aviation applications (all steel surfaces) where fretting corrosion had been troublesome, including open-ended splines, various couplings and universal joints in aircraft. It was found that this grease markedly reduced or eliminated the fretting previously encountered when other greases were used. However, for the reasons mentioned above, its usefulness is limited. Among the greases which had permitted fretting in service were greases J and S, both of which also showed poor anti-fretting properties in the Fafnir rig.

Though there is no direct field data to relate the Fafnir rig to fretting of sleeve bearings (where contact areas are generally greater than in a ball or roller bearing and where dissimilar metals may be in contact), there is evidence that some correlation exists. Thus, greases A, C and G are reported to give adequate performance in the lubrication of automotive chassis, where there are such oscillating sleeve bearings as kingpins and shackles, and these greases show reasonable performance in the Fafnir rig. However, a separate investigation is currently being made to assess directly the anti-fretting properties of greases in reciprocating sleeve bearings, and this will be the subject of another report.

Composition, Anti-fretting Properties.—While it was not the immediate object of the work to determine what compositional and physical characteristics are necessary for good anti-fretting properties, the data obtained demonstrates some trends. Further work is proposed, however, in order to elucidate the requisites for good anti-fretting properties.

It has been suggested by Herbek and Strohecker[6] and E. M. Johnson[7] that such factors as soft consistency, high oil separation and shear instability are all conducive to good anti-fretting properties in greases. While some of the results presented in this paper confirm the satisfactory performance of the softer greases (of the series in Table 3), there are obvious anomalies. These include greases I and J which are much worse as anti-fretting greases than would be expected from their consistencies (No. 2 and No. 1 grade respectively). The results of mechanical worker tests (Table 2) also show no correlation between shear instability and anti-fretting properties.

A more likely explanation of the poor performance of greases I and J is that soap content is one of the basic factors influencing anti-fretting properties. Thus, for a given series (type of composition and method of processing) a reduction in soap content leads to improved anti-fretting properties. This basic suggestion is also consistent with the data given in references 6 and 7, reduced soap content leading to softening, increased oil separation and shear instability.

From the data available, the types of soap and oil do not appear to be major factors, reasonably good anti-fretting greases having been found with a wide variety of gelling agents and with oils differing widely in viscosity and type.

While E.P. properties appear to assist in mitigating fretting-corrosion, similar or better results can be obtained by other means.

Claims have been made that MoS_2 is an effective anti-fretting agent, and tests were therefore made to examine and compare the behaviour of MoS_2 and graphite as anti-fretting additives.

Molybdenum disulphide was found to have variable effects on the anti-fretting properties of the base greases. A 10 per cent addition drastically reduced the excellent anti-fretting properties of grease F1 and also impaired grease L, but promoted some improvement with greases I and J which were poor anti-fret lubricants. A higher concentration in grease I increased fretting. Other greases containing molybdenum disulphide showed poor anti-fretting properties under the conditions examined. The present evidence does not disclose any reasons for the variable performance of molybdenum disulphide in greases, but does not support its indiscriminate use for anti-fretting purposes.

In the one instance where graphite was added to a grease (L1), the anti-fretting properties of the base grease were reduced.

The author wishes to express his thanks to the directors of Shell Research Limited for permission to publish this article and gratefully acknowledges the assistance of his colleagues.

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On the Shelf

By Frank H. Smith

As I walked to the office the other morning, after a strenuous post-breakfast session with my family, I realised that every librarian and information officer should have a large family in carefully graduated steps. He spends his life advising and telling people how to do things. He is used to people asking him for answers and taking them without question. As a result he might get a little big-headed. If, however, he has to deal all the time with a teen-age family he will soon realise that he is the most ignorant man walking the earth today. He really knows nothing at all and his opinion is not worth considering. In fact, it is a matter of marvel that he has contrived to live as long as he has.

From Pergamon comes the sample number of *USSR Patents and Inventions*, an abstract journal. It is described, sub-titularly, as *Organ of the Committee on Inventions and Discoveries of the USSR Council of Ministers*. All I can say is that the USSR Council of Ministers must be an inventive lot. There are 17 main headings each of which is divided into a number of classes. Incidentally, electrical engineering is a class under electronics, which must sound strange to anybody who can remember a time before electronics and might give the I.E.E. food for thought. It is all £50 a year ($150) with lesser rates for sections only. You know the address—Headington Hill Hall, Oxford.

The US Government Printing Office has recently produced a new edition of the catalogue "Government Periodicals" (price list 36) wherein there is an item *Technical Translations*, a new journal, listing and abstracting translated scientific and technical literature available from Office of Technical Services, Library of Congress, SLA Translation Center, cooperating foreign governments (that's us), educational institutions and private sources. It's a semi-monthly (whatever that is) and is $12 a year plus $4 for postage. I think HMSO can do it for you. This incorporates the SLA's (Special Libraries' Association) former *Translation Monthly*.

The Society of Glass Technology (Thornton, Hallam Gate Road, Sheffield 10) produces Volume 1, No. 1, of a two-part journal, *Physics and Chemistry of Glasses* and *Glass Technology*, both started in February. To members they are free and to non-members £10 a year, bi-monthly. Tri-lingual abstract cards are published in each (suitable for 5 × 3 cards).

The American Institute of Physics tell me that they've had a warm response to their *Journal of Mathematical Physics* (No. 1—Jan.-Feb.) which is "devoted to mathematical solutions motivated by physical problems." I cannot feel very warm about it myself but perhaps you can at $11 a year. From 335 East 45th Street, New York 17.

Heinemann (15-16 Queen Street, London, W1) have brought out their 1960 "School Library List." The feature of this is that the catalogue is divided into age groups starting (upwards of course) with eleven. Eleven plus in other words, but this may make parents among you antagonistic.

The British Constructional Steelwork Association (Artillery House, Artillery Row, London, SW1) has, at five shillings, Volume 1, No. 1, of *Building with Steel*—published quarterly and "an informative journal relating to the progress of, and developments in, the constructional steelwork industry."

Cambridge University Press get some delightful titles. In their spring list, for instance: *Ticks*—just like that, with no embellishment apart from a sub-title "A Monograph of the Ixodoidea." Just the thing to read over breakfast. All the same, the list is worth having, especially as it includes their paperback programme. 200 Euston Road, London, NW1, or 32 East 57th Street, New York 22.

Model Decisions

The Key to Accounting and Costing. By J. A. R. TAINSH. *Griffin.* (14*s*)
The Theory of Storage. By P. A. P. MORAN. *Methuen.* (13*s* 6*d*)

How does anyone ever manage to take a decision in the real world? There are perhaps three major problems to be faced: the sheer multiplicity of factors which may bear on the decision, the complexity of the relationships subsisting between those factors, and the likelihood that this whole delicate structure will be animated less by predictable movements than random perturbations.

Before a genuine attempt at a decision can be made, the decision-taker has to list to himself the factors he believes to be relevant; and he will set aside certain other factors as excluded—whether because they are strictly irrelevant, or because the task of taking them into account is too great. Next, the decision-taker has to reflect on the connections that exist between the factors. Some of these may be quite straightforward: there may be a linear relationship between the number of machines and the output of a shop, while the connection between output and profit is likely to be quite determinable although aggressively non-linear. Other relationships are much more subtle, involving judgments about imponderables (such as morale) that are difficult to measure. But the major cause of trouble here is the third difficulty already mentioned—random fluctuations in supply, demand, consistency of product, and so on. The decision-maker deals with these by what he calls experience; more specifically, he is relying on his brain to estimate and compare probabilities in ways of which he can rarely give a conscious account.

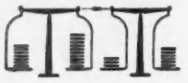
This whole process, by which a manager (for instance) prepares to take a decision, is one in which he builds himself a model of the situation in which he finds himself. "Model" is the word a scientist would use; but it makes a useful label for the representation of the situation the decision-taker employs, however formal on the one hand or intuitive on the other. The point to press is that no one can take a decision about *the actual situation*, for he never has enough information. He takes a decision about a *model* of the situation; and the quality of the decision depends very directly on the adequacy of the model. An understanding of the situation which ignores major factors, misconstrues key relationships, or assumes deterministic behaviour in a real-life flux of events, is a defective model, and it will lead to defective judgments.

Business and industry employ professional model-builders to provide models of the situation which will aid executive decision. To employ a scientist for this purpose is to use operational research. He is mostly concerned with *ad hoc* models to be used in taking particular policy decisions. But the business also needs a comprehensive and continuous model of its activities which presents the firm to itself, its own directors, its shareholders, and indeed the public. It is the function of the accountant to supply that model. This thought may be surprising. For some reason accountancy is often thought of as "supplying the facts about the business." In truth, it supplies facts about the *accountancy model* of the business.

What is the accountancy model? It is a particularly ingenious device in which every fluctuation of the business is made to cause, in the model, an equal but opposite reaction. To study the model, then, is to observe an equilibrium: an equilibrium which is continually upset as real-life movements are fed into the model, and as continually restored by the accountant who recreates a *balance*. This is what double-entry accounting is about. The technique goes back 500 years says Mr. Tainsh; but he must himself take the credit for making the model explicit in a manner of special virtue for engineers.

The essence of Mr. Tainsh's version of the model is shown in the sketch below.

This is a pair of linked balances (the link is weightless and frictionless) in which the left balance represents the balance sheet accounts and the right balance the profit and loss accounts. Debit actions, in both sets of accounts, are represented by the pans with left-hand access; credit actions by pans with right-hand access. This does offer a very clear insight into the real meaning of (for example) "debiting an



account"—which can mean either decreasing *or* increasing the resultant balance. Profit, read on balance, is the difference between that balance's two pans. This must equal, on balance, the difference between assets and liabilities. The whole machine is in equilibrium because the total debits (left-hand pans) equal the total credits (right-hand pans).

Armed with this model, Mr. Tainsh proceeds to upset the equilibrium in most conceivable ways—by making a sale, for instance, or paying off debentures—and observing how it may be restored. The point is made clear each time by a picture of the state of his model. Thus from the first 50 pages, clearly and simply written, a remarkable insight into the whole business may be obtained.

The book continues to be clear and simple as it proceeds to deal with the "paperwork model" corresponding to the mechanical one. But whereas to this point he has been concerned with expounding the application of an important *concept*, the author is now trying to explain accounting *practice*. Purchase, sales and stores accounting, as well as discounts and trial balances, are all dismissed in 11 pages, and only 25 pages are left for costing. Thus explanations become steadily more sketchy, despite some useful diagrams. Readers here need some warning that modern costing practice can be considerably more advanced than this rudimentary picture might suggest. It is best to concentrate on the concepts.

But engineers who may be frightened by accounts will find here a short, simple and helpful explanation. It takes away some of the mystery, and is therefore likely to be denounced as an over simplification by some professionals. However, one might then consider whether the book offers too simple a model of accounts, or whether accounts offer too simple a model of real life. For some decision-taking purposes, the latter is undeniably the case. Consider the problem of stockholding—whether in the form of raw materials or finished goods, work-in-progress, or engineering spares. These are all ways of storing the company's assets, and often tie up a great deal of money. The accounting model of real life is much concerned with these dispositions of capital, which it can (in principle, anyway) measure. It introduces aggregates representing these quantities into its equilibrial mechanism, and notes a deplorable tendency on their part to rise.

Take work-in-progress, for example, and consider two industrial processes, the first of which feeds the second. The accounting model is concerned with the two rates of output and the stock in between. Its figures, produced periodically, integrate output over the period (thereby "ironing out" the random fluctuations). Its concepts, concerned primarily with balances, compare the two rates (declaring a higher rate on one process as a "bottleneck" on the other). If the two rates are different, either one process must be cut back and charged to expensive "idle time," or expensive stocks must be held in between. The decision-taker who uses this model is surely driven to instruct that the two rates ought on the average to be the same. He does not suspect that, if his orders are imple-

mented, the stock in between will steadily rise. The model is defective.

Operational research specialises in building models of situations in which the appropriate factors are included, but in which their relationships are adequately represented, and (in particular) in which the random fluctuations are taken into account. The illustration just given may be modelled in mathematics by a stochastic process, within which the theory of queues can demonstrate that, for equal average output rates on the two processes, the queue of work-in-progress between them will grow infinitely. This is because the probabilities governing the two outputs from job to job interact to create time losses on the second process which cannot be recovered in a finite time.

In fact, all these storage problems are essentially probabilistic: they are governed by relative chances, and by random fluctuations about mean performances. An adequate model has therefore to be drawn from probability theory on the one hand and statistics on the other. Professor Moran's book does exactly this. It concentrates especially on the author's own " Dam Theory " which models a storage problem on a reservoir. Here, the input is much subject to chance variations in supply—as is that of most kinds of industrial stockholding. The water may be fed out continuously, or discretely but regularly, or discretely and at random. With these outputs may be compared respectively the output of any continuous industrial process; the output of a motor-car line, or of spares to a preventive maintenance scheme; the sales from a retail shop.

The theory of storage is another step towards a completely general mathematical model of stockholding problems, a model that seeks to provide rules for the control of each kind of store which will extract maximum return from the capital invested in the inventory. It is particularly interesting to note that the behaviour of most forms of storage, which people often regard as essentially different (for example, raw material, inventory and work-in-progress) are all likely to be modelled by one comprehensive theory; that, for instance, inventory storage (random output) and dam storage (random input) are formally related by their duals (if it is permitted to make use of the mathematical term).

This little book is written essentially for scientists. It is impossible here to give more than its general intention, which is to provide insight into these essentially probabilistic processes, and impossible for anyone who cannot read mathematics to understand it. Given that ability, however, readers will find Professor Moran's book as lucid and concise as they have learned to expect a Methuen Monograph to be. Operational research scientists, in particular, will welcome the publisher's new series, of which this book is the first, on " Applied Probability and Statistics."

Here then are two good little books, each concerned with models of real life for the taker of decisions—for whom their area of overlap is measured by the value of his stockholding of every kind. In that area, the first model is almost too simple not to be dangerous; the second is almost too sophisticated to be of actual use. The manager goes on taking his decisions.

STAFFORD BEER

Look at a Job Objectively

Work Study. By R. M. CURRIE. *Published for the BIM by Pitman.* (22*s* 6*d*)

Work study has recently been exceedingly fashionable. " Has been " because there are signs that a modest reaction has set in, a reaction which was probably inevitable and which will certainly do work study no harm in the long run. The reasons why this should be so are not far to seek. The subject has been over-sold in some quarters by those with more enthusiasm or interest than grasp of techniques; some concerns have found that installing a systematic programme of work study involves an immediate substantial outlay of money (either to consultants or their own staff in a newly established work study department) while returns are slow to come in; others have been exasperated and lost interest because good work-study men are scarce and recruits for a new department could not be found quickly enough at preconceived salary scales.

None of these problems is a valid criticism of work study as such but they have in some quarters taken the zeal out of the more impatient converts. Despite this, the claim of work study as a tool of management and as a technique of analysis remains unimpaired. Experience of recent years has shown that the considered and temperate claims of work study have been amply vindicated and that when simply and modestly set out, as they are in this book, they are substantiated in better working methods, higher productivity, higher wages and lower costs when related to any reasonable set of circumstances. No one with thorough experience and knowledge of work study has ever claimed that single-handed it could work miracles or succeed without the active support of top management.

To technical people, especially to those who have undergone a mathematical, or closely related, discipline, work study has to surmount an initial difficulty and damage has been done, for instance, among engineers, by pretending in some cases that it does not exist. Work study is not an academic discipline or a body of knowledge. It cannot claim to operate according to certain laws or even tendencies. Its nearest point to an academic discipline is its claim to objectivity. It is a call to the trained mind to accept in any industrial context a scientific attitude of mind, an attitude which that mind already accepts in theory. It tells the civil engineer, for example, that the attitude of mind (so far as analysis is concerned) which gives him the right approach to building a dam should be adopted in holding his razor when he shaves in the morning. It is true that work study has something to teach us all for we are all prone to use our objectivity only in contexts which suit us.

Then comes the complication. Work study consists of two parts, method study and work measurement. On method study there is no difficulty but in work measurement (what is often called time and motion study) there is a basic subjective element. If a job is broken down into its constituent parts (its elements) and timed repeatedly, a body of fact emerges. An average, a median, or what you will, can be established. But in answering the question (which is critical for fixing a rate): how long should the job take? The time-study engineer must use his personal observation and his experience to a large extent. Judgment and not fact is therefore at the back of it. Work study had been fighting a long battle, now just about won, with its detractors to prove that the answer which was wanted in the first place is not substituted for judgment.

This book, written by the impressario of one of the largest and most successful work-study groups in the country, is a useful guide to the potentialities and practice of work study. It has been developed from the three well-known British Institute of Management pamphlets on the subject and is indeed an expansion and bringing up to date of these booklets. It embodies the experience of Imperial Chemical Industries' work-study departments, the Central Work Study Department of which Mr. Currie has presided over for years. Its style is clear and the layout convenient for the student. It has indeed been designed for those offering work-study papers in the examinations of the Institution of Mechanical Engineers, the Institution of Production Engineers and the City and Guilds of London Institute. it will be equally useful for the manager anxious to get a quick and accurate grasp of the bare essentials of the subject.

This is not a book intended for work-study experts who wish to argue over finer points of technique nor will it make a work-study engineer out of an inquiring executive. But it will give student, manager and technician the elements of work study and so fill a gap. It is a worthy successor to the BIM pamphlets which already set a standard of exposition.

G. E. TEWSON

Amusement in the Abstract

On Mathematics and Mathematicians (Memorabilia Mathematica). By ROBERT EDOUARD MORITZ. *Dover Publications, New York; Constable, London.* (16*s*)

Though mathematicians are still in short supply, the number of those interested in, and who use, mathematics has shown a very large increase since 1914, when this book was first published. Do not be deterred by the date: many among this growing company will find much to enlighten and amuse them in this encyclopaedia of mathematical quotations, the present volume being a new, inexpensive and complete edition of the original book.

It consists of quotations from the works of great mathematicians, from their lectures and from their biographies. The quotations are grouped under some twenty headings, making those on any part or aspect of mathematics readily found. There is also a full index giving the quotations which refer to particular mathematicians or topics.

The author spent 10 years over the collection and compilation of the work. Ten years of hard but most attractive work. His time was well spent. Regarded purely as literature and as a demonstration of the concise and attractive use of our own language the passages would be highly rated.

The work is not one to be read through at a single go, but rather to be used as a bedside book, a page or two now and then. What they said about Newton one night, Laplace another, the origin of the calculus another, and so on. Invaluable to the schoolmaster wishing to give an historical background to his work, and zest to the engineer's more mundane job of applying, perhaps unknowingly, the processes that Newton and Laplace evolved. Many engineers will be interested to learn the origin of the basic principles which they use and what sort of people their inventors were: how they worked, how they wrote, and the esteem in which they were held

Continued on next page

by their contemporaries.

A most excellent book for any school, college or works common room library but above all a book to own and to be taken in small doses.

Pillow Problems and a Tangled Tale. By LEWIS CARROLL. *Dover Publications, New York; Constable, London.* (12*s*)

This volume holds two books, both of problems. Again these are inexpensive reprints of earlier publications. The pillow problems, as the author explains, he set himself and solved while lying in bed. He used them as counter irritants to more vexatious matters, believing that mental effort was the surest relief, and the best inducer of sleep. He gives the solutions he gave himself in bed without the aid of pencil and paper; suggesting that in some cases he and in fact some of his readers could produce neater solutions; some readers, he points out, have produced neater solutions, others quite wrong solutions.

The problems and solutions show much ingenuity, they are neat and varied, though picking out balls from a bag is rather overdone. They require no more mathematics than the usual grammar school provides, but for most of us, a bit of pencil and the back of an envelope would be essentials. They should afford excellent relief to the harassed engineer, whose one-time interest in mathematics has become jaded by too much limited application.

The second half of the volume, "A Tangled Tale," is a set of mathematical puzzles, each camouflaged in a whimsical story in a style reminiscent of Alice. Each of ten stories contains one or more simple puzzles. The author gives his solution and discusses other solutions he received when these tales first appeared in *The Monthly Packet*. Here again the puzzles are inside the compass of a grammar school requiring less mathematical ability than the first half of the volume.

If you still enjoy your Alice you will like them. They afford good practice in sorting out essentials from a mass of irrelevant detail. To misquote the author " It will give them a little instruction. But is there any great harm in that so long as they get plenty of amusement."

Symbolic Logic and the Game of Logic. By LEWIS CARROLL. *Dover Publications, New York; Constable, London.* (12*s*)

Again, this is a volume containing two books. The second of these rather a repetition of the first, albeit in a more sporting fashion. Unlike the two previous volumes, this one requires careful, systematic reading. It is not a bedtime book. It is an attempt (it was probably the first attempt) to express classical logic in symbolic form. Book two takes this a stage further and reduces logic for beginners to a game played with counters. This game as the author points out requires at least one player.

Each, or both books, provide a good course for beginners in logic. There are many entertaining examples to which the author gives answers and solutions. The definitions are clear and the explanations very readable. This book will appeal to a minority of engineers—those who wish to sharpen their wits with no special object in view.

E. D. HODGE

New Books

Higher Electrical Engineering. By J. SHEPHERD, A. H. MORTON and L. F. SPENCE. *Pitman.* (40*s*)

The authors have sought to provide a textbook which will cover the whole course for A1 and A2 years of the higher national certificate in electrical engineering. The book also covers much of London University and City and Guilds syllabuses.

Millimicrosecond Pulse Techniques. By I. A. D. LEWIS and F. H. WELLS. 2nd edition. *Pergamon Press.* (50*s*)

A brief theoretical introduction for the non-electronic physicist is followed by a consideration of basic circuit elements and equipment of universal application. The last two chapters are concerned with specific applications, largely nuclear.

Proceedings of the European Congress on Ground Movement, held at the University of Leeds, 1957. *The University, Leeds 2, Yorks.* (42*s*)

The Congress was sponsored by the University of Leeds and the National Coal Board, and included contributions from France, Holland, Germany, Austria and the Saar. The first paper, given by the President of the Congress, Professor J. T. Whetton, takes the form of a general survey of the problem.

Theory of Plates and Shells. 2nd edition. By S. TIMOSHENKO and S. WOINOWSKY-KRIEGER. *McGraw-Hill, New York and London.* (£5 16*s* 6*d*)

A great deal of progress in these fields has been made since 1940, when the first edition was published. Five new chapters and one substantially expanded appear in the plate section, while, in the shell section, the authors have contented themselves with minor additions, plus bibliographical reference to recent developments.

Analytical Elements of Mechanics. By THOMAS R. KANE. Volume 1. *Academic Press, New York and London.* (38*s*)

The first of two volumes intended for use in courses in classical mechanics, the ultimate purpose of which " is to teach the student how to solve physically meaningful problems arising in a variety of fields." Divided into vector algebra; centroids and mass centers; moments and couples; and static equilibrium.

Electricity Undertakings of the World, 1959-60. *Benn Brothers.* (30*s*)

The Electrical Journal Red Book, now in its 69th edition, gives details of authorities, services and stations in Great Britain, the Commonwealth, and the rest of the world. A name index of persons mentioned is very useful.

Servomechanisms and Regulating System Design. By HAROLD CHESTNUT and ROBERT W. MAYER. 2nd edition. Volume 1. *John Wiley, New York; Chapman and Hall, London.* (94*s*)

A new edition with major additions of a book intended " to train design and application engineers in the basic principles of feedback control," and adapted to the needs of engineers and students without previous experience in the field.

Sovyetskiye Ekspeditsii v Antarktiku, 1955-1959 gg. (Soviet Antarctic Expeditions, 1955-59.) By A. V. NUDELMAN. *The Academy of Sciences of the USSR, Molodezhnaya 3, Moscow, B-296.* (Free of charge.)

A summary of the work of the 1st, 2nd and 3rd Soviet Antarctic Expeditions. Seven stationary scientific bases were established, and research included an aerophotosurvey of the coast between 40° and 166°W, rocket soundings of the atmosphere, and oceanographic surveys.

British Coal Utilisation Research Association: Bibliography of Publications, 1938-1959. *The Association, Randalls Road, Leatherhead, Surrey.* (5*s*)

Issued to mark the 21st anniversary of the Association, the bibliography shows where accounts of past and present research have been published, both in BCURA reports and elsewhere.

Analysis of Deformation. By KEITH SWAINGER. Volume 4: Waves and Vibrations. *Chapman and Hall.* (75*s*)

Chapter 10, concerned with geophysics, presents a unified mechanistic theory of the cause of earthquake waves, volcanoes and the crustal features of the earth, and their relation to the physiography of the sun and the moon.

Performance and Efficiency Tests: Southern Region Modified Merchant Navy Class 3 Cyl. 4-6-2 Express Passenger Steam Locomotive No. 35020. *British Transport Commission.* (10*s*)

When Mr. O. V. S. Bulleid built the Merchant Navy locomotives he incorporated some novel features in the design—especially the chain-drive valve gear enclosed in an oil bath. Though the locomotives have " given sterling service," some of the novel features have had to be eliminated. Tests on one of the modified locomotives are reported. The report includes " what must rank among the best performances of the Merchant Navy locomotive."

Festskrift til Professor Anker Engelund. *Research Laboratory of Building Technique, Technical University of Denmark, Copenhagen, Denmark.* (250 *Dkr*)

A 70th birthday offering to Professor Engelund, made up of 21 papers in Danish or English on soil mechanics, models in hysteresis study, shells and other topics.

A Simple Approach to Electronic Computers. By E. H. W. HERSEE. *Blackie.* (12*s* 6*d*)

The author has tried to present in some detail, and as simply as possible, some of the basic working principles of digital and analogue computers, in order to demonstrate the essential simplicity of their components.

Vocabulaire Technique: Electricité, Mécanique, Mines, Sciences, Métallurgie. English/French, French/English. By FRANCIS CUSSET. 5th edition. *Editions Berger-Levrault, 5 rue Auguste-Comte, Paris 6, France.* (16 *NFrs*)

An overcoat pocket-sized technical dictionary, with a short section on conversions.

The Reviewers

Mr. Stafford Beer is head of the Operational Research and Cybernetics Department of the United Steel Companies Limited.

Mr. G. E. Tewson is a partner in the firm of O. W. Roskill Industrial Consultants and an M.A. in economics and political philosophy.

Mr. E. D. Hodge is mathematics master at Manchester Grammar School. He holds an honours B.Sc. in mathematics and is the joint author of several mathematical text books for schools.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Nuts, Screws, Washers and Bolts

Lock Washers. PALNUT CO. LTD., 3 Arthur Street, Hove 3. Palnut anti-vibration lock nuts for all bolt sizes from 6BA to 3 in BSF. Booklet gives range and examples.

Fastenings. SIMMONDS AEROCESSORIES LTD., 11a Albemarle Street, London, W1. " Spire " Speed nuts and fastenings for all industries. Examples given in 14 leaflets. Also Speed Screws and locking nuts with fibre or nylon inserts. Leaflets.

Rope Terminal. TULLOCH CONSTRUCTION CO. LTD., 8 Laurence Pountney Hill, Cannon Street, London, EC4. Tullcon wire rope terminals for site fitting. Passed Lloyds test for ropes of 1 in, ½ in, ⅜ in, ¼ in, and ⅛ in diameter. Leaflet.

Polythene Pipe Flanges. FOSTER BROTHERS LTD. Lea Brook Tube Works, Wednesbury, Staffs. Bulldog clamping flanges for polythene pipe; upset under controlled conditions. Closed with steel backers. Illustrated leaflet gives sizes.

Bayonet Connectors. SMITHS AIRCRAFT INSTRUMENTS LTD., Kelvin House, Wembley Park Drive, Wembley, Middlesex. Straight and elbow BNC bayonet connectors, ptfe insulation, carrying up to 1A at 500V. Catalogue.

Storage Tanks. MARKLAND SCOWCROFT LTD., Cox Green Works, Bromley Cross, Nr. Bolton. Storage tanks for all liquids. Rectangular up to 3,000 gallons, circular up to 10,000 gallons. Leaflets.

Control Valve. SIMMONDS AEROCESSORIES LTD., 9 St. James's Street, London, SW1. Control valves for liquid flow. Automatic cutoff for excess rate. Up to 800 g.p.m. at 120 lb per sq. in and 150° F. Folder.

Screw Conveyors. LINK-BELT CO., Dept. PR, Prudential Plaza, Chicago 1, Illinois. Screw conveyors and feeders, horizontal, vertical and inclined; single or multiple. Details of component parts, sizes, capacity, horse power requirements and design details in a 76 page booklet No. 2989.

Marketing

Trade Prospecting in Sudan and Ethiopia

Trade prospects in Ethiopia and the Sudan are being surveyed by Mr. George Nelson, managing director of the ENGLISH ELECTRIC Company.

Mr. Nelson is travelling in his capacity as industrial leader and vice-chairman of the Board of Trade's advisory council on Middle East trade. He will be making the usual contacts with Ministers and government officials and with businessmen.

A party drawn from the advisory council were recently in Egypt and other countries of the Middle East.

Mini-Minor and Others at Copenhagen

The NUFFIELD ORGANISATION put in a special effort at the recent Copenhagen Motor Show, emphasising the Morris Mini-Minor and using a special 21 ft turntable carrying three Morris Minor 1000's mounted on their sides to show construction details.

The Minor 1000 has a considerable following in Denmark and the Nuffield sales team supported their turntable effort with a Minor Traveller, Minor Saloon and a Minor Tourer.

Far south of Denmark another Mini-Minor, driven by the general manager of the COMPANIA DE AUTOMOVILES ANGLO-PERUANA, SA., Nuffield distributors in Lima, Peru, has successfully emerged from a proving trip over the Andes carrying three passengers. Encountering the rarified atmosphere of 15,000 ft and bumpy, serpentine roads only recently under floods, the Mini-Minor is said to have emerged with a highly creditable performance.

Car Repairs at Brno Trade Fair

An impressive amount of forethought goes into the planning of the Brno Trade Fair, which is already certain of the support, in September, of most of last year's exhibitors and some important new participators.

In order to encourage visitors who want to go to the fair in their own cars the authorities have set up a commission which will establish new vehicle repair shops, car parks and service stations.

Services will not only be concentrated close to the site of the fair. Main roads linking Brno to international motor routes are to have their service facilities improved.

Germanium Rectifier for Australia

A second major order within three months for germanium rectifiers for a smelter in the aluminium industry has been received by the Heavy Plant division of ASSOCIATED ELECTRICAL INDUSTRIES. The new order is for equipment worth more than £400,000, with an installed capacity of 42 MW for an extension to the smelter at Bell Bay, Tasmania. The smelter is owned by the AUSTRALIAN ALUMINIUM PRODUCTION Commission, who before placing the order made a world tour of rectifier makers receiving tenders from British, American, European and Japanese firms.

The plant is due for commissioning next year. Most of the equipment will be made at Rugby.

Foundry 2,500 ton Record

The DISTINGTON ENGINEERING Company's iron foundry has become the first in Europe ever to produce more than 2,500 tons of finished castings in a week.

The foundry's output for the week which ended 20 February was 2,520 tons of ingot moulds, bottom plates, slag ladles and general engineering castings.

The company is one of the UNITED STEEL Group. Its Workington, Cumberland works were established in 1946.

The new record follows two months after the achievement of the British and European output record. The foundry's experience over the past three months indicates that these very high output figures can be kept up over prolonged periods. The group has a satisfactory order book position and the published figures for future capacity in and demands upon the steel industry suggest that the record may not stand for long.

Pressed Steel works for Jarrow?

There is a possibility that the North-East, which has so far been unlucky in the car firms' expansion plans, may be chosen by the PRESSED STEEL Company as the area of a new factory.

The exact location if negotiations are brought to a successful conclusion would be somewhere near Jarrow, whose unemployment is above the national two per cent.

Pressed Steel, large-scale manufacturers of car bodies and rail wagons, are expected to spend between £20 and £25 million on development in the early 1960's. The Board of Trade clearly would be unlikely to support expansion ideas of this scale in the well-employed Oxford area, where the Pressed Steel company produce their car bodies at Cowley, just outside the city.

No light yet appears on the gloomy horizon before shipping, and large scale diversification of the North-East coast looks as if it will become a necessity if serious unemployment of skilled and semi-skilled operatives is not to be allowed to occur.

Record Quarter in Constructional work

The value of constructional work by contractors in Great Britain in the last quarter of 1959 was £509 million. An increase of only £2 million over the previous quarter the figure is still a record for the industry. The value of the work in the whole of the year is estimated at about £1,976 million, which is £156 million more than in 1958.

The largest increase in 1959 over the previous year was in the field of new housing by private developers; the 1958 figure of £264 million was improved to £323 million. Work on housing for public authorities, almost equal in 1958 at £254 million, declined to £245 million.

While the index of construction costs has gone down slightly the index of production is up by a larger degree. Taking 1954 as 100, average construction costs in 1958 were 115 and last year—113. The base line for production is also 1954 and the two years under comparison averaged 108 and 111. After allowing for statistical changes production is estimated to have increased by 6 per cent over 1958.

Rutherford to Rotodyne at New York Fair

The British Trade Fair in New York this June is evidently to impart to the curious American something of the history of engineering and industry in this country at the same time as convincing him of our general up-to-dateness and ingenuity.

The plans of the FEDERATION OF BRITISH INDUSTRIES are now coming somewhere near the final stages. Some of the details of the attempt to fill in some of the historical background show the breadth of the Fair's exhibits.

It is likely that the original Whittle jet engine will be seen beside a sectional diagram of the Conway engine. Some of Lord Rutherford's "primitive" apparatus is expected to appear with a nuclear reactor simulator from the Atomic Energy Authority.

A sample of the most recent antibiotic drug, developed from Sir Alexander Fleming's discovery—6APA (amino penicillanic acid)—may be shown with a mould of the penicillin first developed by Sir Alexander.

Among the long list of industrial products and manufacturing equipment which will be shown or depicted are ENGLISH ELECTRIC's Deltic diesel locomotive and Priest Rapid's turbo-generator, the DORMAN LONG universal beam mill and the BRISTOL Proteus engine.

The Rotodyne and the DH 121 will appear as models and there will also be some FBI attention to ship models although most of the shipping effort will come from the SHIPBUILDING CONFEDERATION.

Some of the exhibits will be more than familiar to American industrialists. The TAYLOR AND HOBSON television zoom lens is used in the great majority of television cameras in the United States. The HALMATIC fibre glass bow-section is appropriate, coming from a firm already making fibre glass trawler hulls for the American market.

Car Battle in Geneva

There is nothing neutral about the Geneva Motor Show despite its location.

This year, with the scent of something like a revival of Swiss interest in the British-made car, representatives of United Kingdom car firms have been extolling their products and service arrangements to the Press with almost American fervour. The SOCIETY OF MOTOR MANUFACTURERS AND TRADERS obtained pretty tri-lingual girls for its cocktail parties and their German competitors, Volkswagen, were driven to introducing tri-lingual headphone assemblies, an instantaneous translation system copied from the diplomatic assemblies of the Swiss capital. The British share of the Swiss car market has fallen to 8·5 per cent and some executives have discovered the length of Swiss memories for past shortcomings.

First indications at the show suggest that an improvement in the United Kingdom position is under way. All six ROLLS-ROYCE models were sold on the first day of the show, the first time it has happened; and the ROOTES GROUP sold six cars on the first day, which has also never happened before.

Who Invented Dexion?

The DEXION organisation is currently telling a good story about a Russian engineer, a roof and themselves.

The engineer went to a Russian trade exhibition in Colombo, Ceylon, and supervised the erection of the main roof, stressed wire covered with tarpaulin, over the 160 ft by 60 ft main exhibition hall.

Four days before the exhibition had even opened the roof was sagging noticeably after heavy rain.

Better to be safe than sorry. Dexion were brought in and in four days put up a new roof of slotted angle and corrugated aluminium sheet without delaying the opening.

All that remains now is for a Russian encyclopaediast to claim that Dexion was invented in the 18th Century by a Moscow workman.

The Train on Platform Seven

A three-stage operation of design, manufacture and installation of the public address and passenger announcement systems for the British Railways, Harlow, Essex, and Stratford-on-Avon stations is to be carried out by EASCO ELECTRICAL (HOLDINGS) Limited, the South London electronic engineers.

The installation at Harlow is expected to be complete next month and at Stratford in May.

I Thought What You Said . . .

The theory of communications, a director's view of communication in a large organisation and the practical problems of office communication will all be dealt with at the one-day conference of the OFFICE MANAGEMENT ASSOCIATION, London branch, on 30 March.

The Postmaster General, Mr. J. R. Bevins, will be there to speak on present and future Post Office developments.

The director's experiences will be explained by Mr. J. E. Wall, a director of ELECTRIC AND MUSICAL INDUSTRIES Limited.

German Military Orders for Greece

Herr Strauss, the West German Minister of Defence, took the chance offered by his visit to Athens to announce a further German forces order for Greek industry, this time ammunition and orders for the Bundeswehr worth £3 million.

Previous German orders in Greece are valued at £5,800,000.

While Herr Strauss was in Athens he was able to deny suggestions that Germany had any interest in supply bases in Greech or Turkey—or any other country outside the supply lines for which Germany was responsible.

Fatigue Strength of Five Types of Stud

Five forms of Whitworth stud were investigated to test their strength under repeated axial load. A stud with a relieving groove was found to be most satisfactory.

By A. F. C. Brown, B.Sc., A.M.I.Mech.E., and W. McClimont, B.Sc., A.M.I.C.E., A.M.I.Mech. E., M.I.Mar.E.

This investigation formed part of a programme of research by the British Shipbuilding Research Association. The object was to compare the fatigue strengths of various designs of mild-steel stud when subjected to pure axial loading. The test specimens were all based on a 1 in nominal diameter 8 tpi Whitworth-thread form and five stud designs were tested:—

(*a*) a collar stud in which the action of screwing into the socket secures the stud against a collar having a diameter of 1·375 times the thread major diameter;

(*b*) a relieving-groove stud which is similar to the collar stud except that the collar diameter is equal to the major diameter of the thread, and the opening of the socket has only a very slight bevel;

(*c*) a bottoming stud in which the securing face is at the bottom of a blind hole in the socket, and takes the form of a conical seat with an included angle of 120°;

(*d*) a normal stud, which locks itself in the socket where the stud thread runs out to nothing, the run-out being specified as having its full effect in a quarter of a pitch;

(*e*) a recessed stud, which is similar to the normal stud except that there is a parallel bore at the socket entry having a length of 0·375 times the major diameter.

The experimental programme was in two parts. First, an investigation of the stress distribution was carried out using the "frozen-stress" method of three-dimensional photo-elastic stress analysis. The tensile stresses at the roots of the threads were measured at every ¼-pitch along the helix. Two curves were prepared for each design representing the tensile thread-root stresses plotted along the helix; the lower curve showed the stresses induced by the process of screwing the stud into its socket and the upper curve showed the stresses caused by the combined effects of tightening torque and an applied axial load. These results are shown in Fig. 1. Secondly, for each design of stud, a series of fatigue tests was carried out. The minimum mean stress of the cycle was 3 tons per sq. in, calculated on the area at the root of the threads. A brief survey of the tightening torque normally applied in the fitting of 1 in diameter Whitworth studs gave an average value of 160 lb-ft which was applied as a standard for assembly of all the specimens. The results of the five series of tests are plotted in the form of S/N diagrams in Fig. 2.

The photo-elastic analysis indicated that the collar and relieving-groove studs were superior to the normal and bottoming studs; it was not possible to conclude from these tests whether the collar stud or the relieving-groove stud would perform better in fatigue. The bottoming stud was clearly indicated as the most unfavourable design for fatigue loading since the threads are fully exposed to any variation in load transmitted from the shank of the stud.

The normal stud and recessed stud are in a different category from the others owing to the high stress in the stud thread at the run-out; this stress could not be measured photoelastically, but it was clearly sufficient to cause yielding in steel. The results suggested a marked improvement in performance resulting from the use of the recess. An obvious effect of the recess is to hold the stud and socket in close axial relationship, which in turn has the effect of removing the variation of stress around the helix arising from the inherent asymmetry of the screw thread. This polar variation of the stress, with the maxima at intervals equal to the pitch, was particularly apparent in the case of the normal stud. The threads of the normal stud appear to jam near the free end on account of the bending introduced at the run-out, so that this design tends towards that of the bottoming stud. This tendency is eliminated by the recess, there being no polar variation of stress. A second effect of the recess is to stiffen the socket where it locks the run-out of the stud threads and it is presumably this factor which causes the rather unexpectedly low stresses measured on the recessed stud.

From earlier experimental work it may be accepted that the effect of the variation of mean stress has no significant effect on the values obtained for the safe ranges of stress. From Fig. 2, the highest limiting fatigue range (± 7·3 tons per sq. in) is obtained with the relieving-groove design, followed in descending order by the recessed stud (± 6 tons per sq. in), collar stud (± 5·6 tons per sq. in), normal stud (±5·1 tons per sq. in), and bottoming stud (± 4·3 tons per sq. in).

These results are in substantial agreement with the predictions of the relative fatigue performance of the different designs which were indicated by the photo-elastic stress analysis.

Photo copies of the complete paper, on which this digest is based, may be obtained from the Publisher, ENGINEERING, *36 Bedford Street, London, WC2, price 15s ($2·25 to the United States and Canada), postage paid. Remittances should accompany the order.*

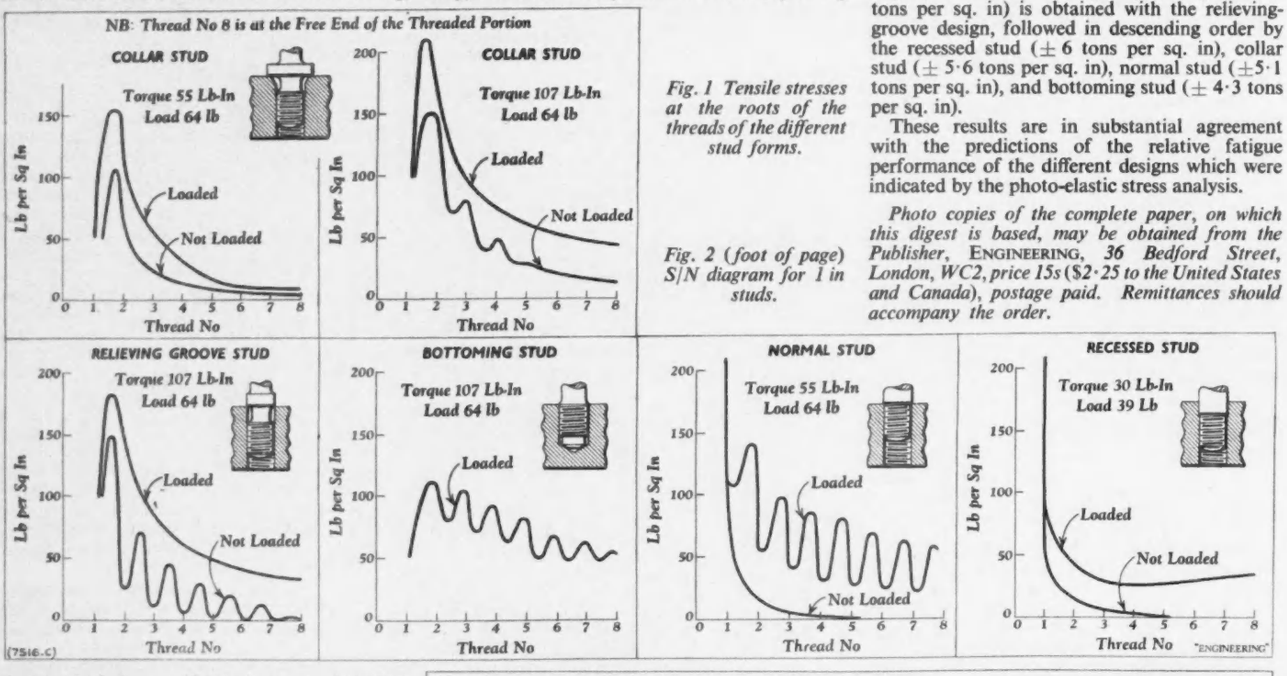


Fig. 1 Tensile stresses at the roots of the threads of the different stud forms.

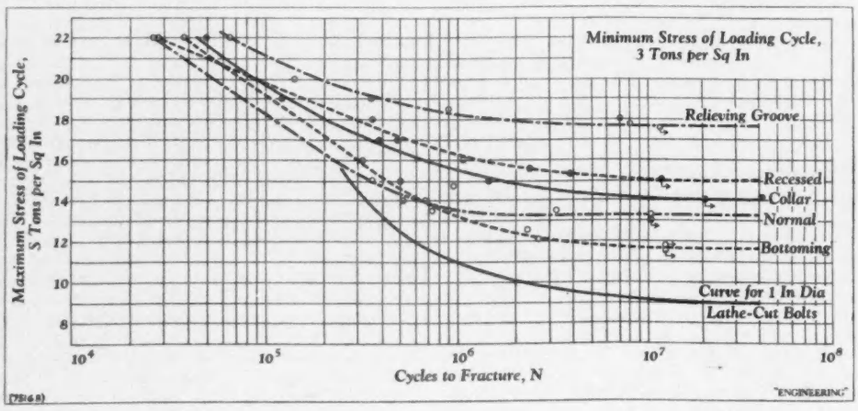
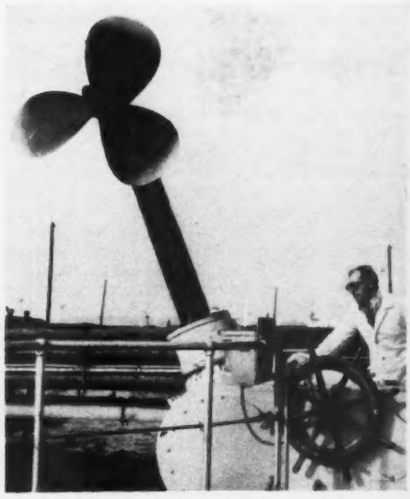
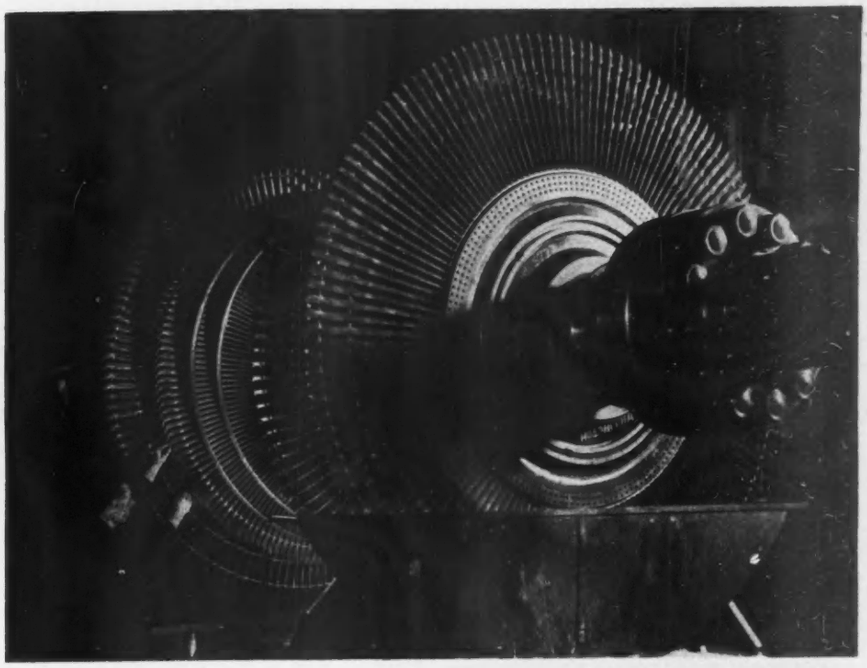


Fig. 2 (foot of page) S/N diagram for 1 in studs.



(*Above*) *One of the propulsion units of the BP Firemaster, showing the stem elevated and the propeller in an athwartship position.*

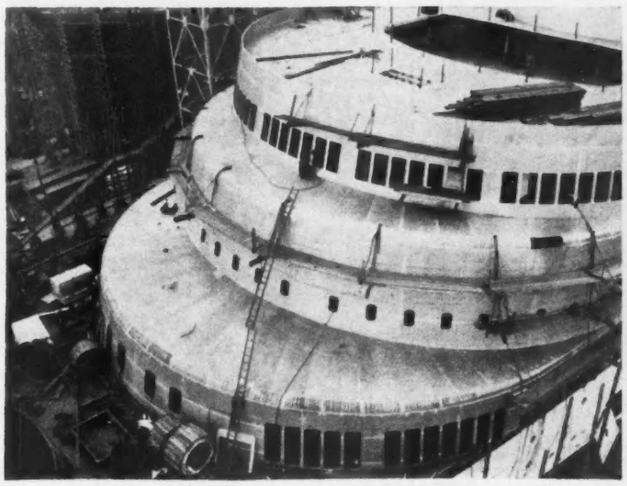


(*Right*) *Steam turbine rotor of 200 MW turbine-generator for CEGB's Willington B power station, during construction by Associated Electrical Industries.*

(*Below*) *A twin-powered scraper TS-24 made by Euclid (GB) Ltd., recently delivered to Shellabear, Price Ltd.*

(*Right*) *View of English Electric locomotive for the Sudan Railways, showing the main items of equipment in position.*

(*Below*) *Looking down on the observation lounge under construction high in the bridge of the P and O Canberra, launched at Harland and Wolff's yard in Belfast last week.*



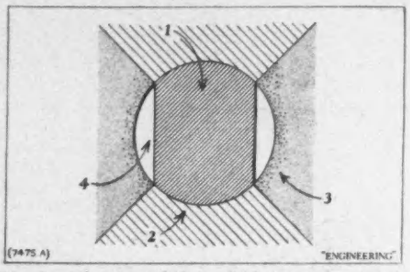
(*Below right*) *Four rocking motors, by English Electric and Grantham Electrical Engineering Co., mounted on a machine for withering freshly-picked tea leaves.*

Undercarriage Bearing is Heat Insulating

In the design of aircraft for supersonic flight, problems arise due to heating of the aircraft structure at very high speeds. Where it is desired to use light alloys, air conditioning is used to keep the temperature of the components down so that the strength of these light alloys is unaffected. This treatment may not be fully effective for certain parts (for example, undercarriage attachments) in intimate contact with the heated aircraft structure.

Undercarriages take heavy loads on landing and great structural strength is required; but this strength is not needed in the retracted position when the problems of heating arise. A heat insulating bearing, designed by Electro-Hydraulics Limited, Liverpool Road, Warrington, Lancashire, may be used in these circumstances. It is illustrated in Figs. 1 and 2.

The bearing is formed in two parts. The section marked 2 in the illustration has high strength, while 3 has good insulating properties. The shaft, 1, which is to be supported, has high strength. In Fig. 1, the shaft, which is cut away at 4, is in contact with the high strength part, 2, of the bearing to take landing loads. In this position the speed of the aircraft is relatively low and the heating problem does not arise. Fig. 2 shows the shaft rotated into the undercarriage-retracted position and supported by part 3 of the bearing. The shaft is insulated from part 2 which may be at high temperature.



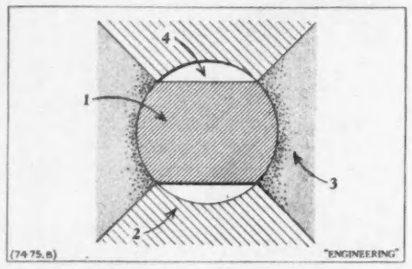
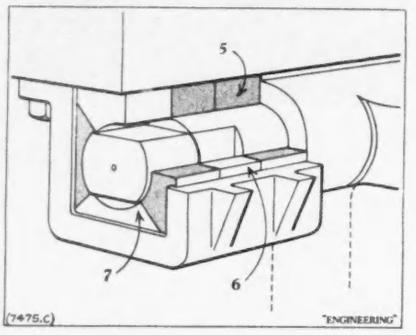


Fig. 1 (above) Shaft 1, which is cut away at 4, is in contact with the high strength part 2 of the bearing to take landing loads.

Fig. 2 (above right) The shaft, rotated into the undercarriage-retracted position, is supported by part 3 and thus insulated from part 2, which may be at high temperature.

Fig. 3 (right) Application of the bearing to take load in two planes.

Fig. 3 shows an application of this type of bearing to take loads in two planes. The shaft is supported in a bearing, 5, of good insulating properties and may also be supported in two-part bearings of high strength to take loads in two planes. These are shown at 6 and 7. When the shaft is rotated through 90°, it is supported in the high strength part bearings.



Steam Generators at Little Barford B

Steam generators Nos. 5 and 6 of Little Barford B generating station were designed and constructed by Foster Wheeler Limited, London. Each boiler has a maximum evaporation of 550,000 lb per hr at a pressure of 950 lb per sq. in at the superheater outlet, and a final steam temperature of 925° F, and is a single drum, natural circulation water tube unit with a water-cooled combustion chamber, having a two-stage horizontal drainable and ventable convection-type superheater and fitted with a non-steaming economiser. An air heater is also provided.

Each boiler is fired with pulverised fuel fed to intervane type burners supplied from two Foster Wheeler type ball mills and their associated coal feeders, classifiers, exhausters and distributors. Oil-fired burners are provided for lighting-up purposes, together with their ancillary equipment. Automatic combustion and final steam temperature control arrangements are fitted, together with steam purity recording equipment. The combustion chamber of each boiler is of ample proportions and is of such height as to ensure substantial cooling of the gases before they enter the superheater enclosure, and is waterwall-cooled on the front, rear, roof and sides, and is also provided with a water-cooled dry bottom.

All steam generation takes place within the tubes forming the combustion chamber, and this allows a non-steaming economiser to be provided without the use of any convection generating surface. The furnace slag screen and secondary superheater tubes are so pitched to ensure maximum protection against slag build-up at these critical points. The steam and water drum is of 5 ft 6 in internal diameter, made from seamless forged mild steel, with manholes at each end and machined overall. Water from the drum flows through feeder tubes to a downcomer main, which in turn delivers to four headers at the base of the combustion chamber. The side walls of the combustion chamber are formed by closely pitched tubes connecting the lower side wall headers to upper headers from which riser tubes discharge the steam and water mixture to the drum.

The superheater of each boiler is of the convection multi-looped type having primary and secondary sections with inlet, intermediate and outlet headers, the primary section being sited in the zone of the lower gas temperature, and the secondary section in the hotter zone immediately behind the slag screen. The primary inlet header, which receives the saturated steam from drum, is the condenser control header for maintaining the desired steam temperature and is provided with two tube bundles though which flows a controlled portion of the feed water, this water by-passing the economiser. Positive control of the final team temperature at 925° F, from 440,000 lb per hr evaporation to full load, is ensured by means of this Foster Wheeler condenser type of control. Some of the steam entering the primary superheater tubes is condensed and has to be re-evaporated before superheating can take place.

Self-inverting Barges

A special group of barges has been designed, by IHC, The Hague, Holland, for dumping rock, debris, stone, concrete blocks and any kind of spoil that cannot readily be dumped by barges fitted with bottom doors. There are two different types of craft. One is the bascule (or self tipping) barge, so designed that it can be listed to about 45° to discharge its deck load over the side, after which it automatically returns to the horizontal. The other, dealt with here, is the self-inverting barge or pontoon, which is specially suitable for sticky material. Its most interesting feature is that it purposely turns turtle through 180°, so that the bottom becomes the deck (and vice versa), an operation that may be repeated indefinitely.

When the deck has been loaded, the pontoon is towed to the place of discharge, where a valve situated below the load waterline is opened to permit the flooding of a tank, which causes listing to the point of vanishing stability.

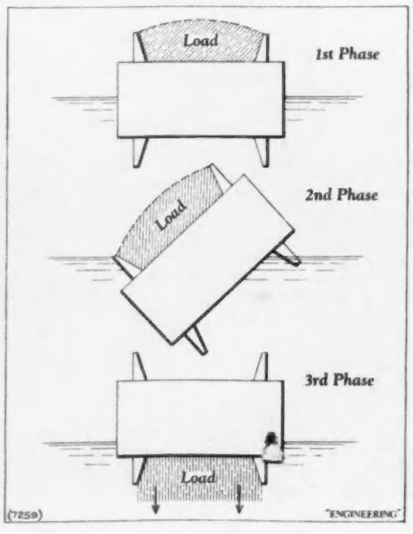
The pontoon turns through 180°, and the deck which was loaded now becomes the bottom. The load has now been discharged and the pontoon is floating at her light draught. The tank automatically empties through the valve (which is still open) and now, of course, above the waterline. This valve is then closed, and the pontoon is ready for reloading in its reversed position. These pontoons are very simple to operate, and because they have no complicated mechanical auxiliaries, they do the job extremely well.

The three phases of the operation are illustrated on the right.

First Phase: *Shortly after opening the valve.*

Second Phase: *Increased listing.*

Third Phase: *Operation completed. The load has been discharged and the bottom surface of the pontoon has now become the deck and is ready for loading.*



Measuring Wear in Large Diesel Cylinders

Although radioactive techniques for measuring engine wear have been used for some years, they have not told us much about cylinder wear. This is because it has been much easier to irradiate small things such as piston rings than to irradiate complete cylinders; and wear rates in rings have little relation to cylinder wear rate. However, cylinder wear rate is more important to the manufacturer and the user of engines—cylinders are more expensive to replace than piston rings.

The development of pool-type reactors—water cooled and water moderated—has made it possible to irradiate larger items of equipment An account of the irradiation of a 42 in long cylinder used in a Fairbanks and Morse opposed-piston diesel engine of 8¼ in bore by 10 in stroke was read at the annual meeting of the Society of Automotive Engineers at Detroit. The paper "Radioactive Cylinders—A Tool for Wear Research," by W. C. Arnold, V. T. Stonehocker, W. J. Braun, and D. N. Sunderman, describes how the 160 lb liner was activated and the methods developed to handle and install the "hot" liner in a test engine.

SHIELDING

Since the area of maximum wear in the opposed cylinder engines is at inner-dead-centre of the compression ring travel, an attempt was made to irradiate this point to a high level of activity. If a technique could be developed for measuring wear at this point, it would be possible to shift later test work to other areas of the bore. To concentrate radiation in the required area, cadmium and boral were used as shielding elements for the other areas. Cadmium metal foil was used for the external surface of the liner, because of its formability, and boral alloy was selected for the internal shield, because its activation products would create a minimum post irradiation hazard. The unshielded target band was 1½ in wide. Irradiation work was carried out by Battelle Memorial Institute.

The shielded liner was installed in a water-tight aluminium capsule filled with helium under pressure. An irradiation period of 4 weeks was chosen. Within the reactor the cylinder liner assembly was attached to a drive mechanism that rotated it at 1 r.p.m. to produce an extremely even irradiation. On removal from the reactor, the liner was placed in a large diameter lead shield and taken out of its capsule.

The attempt to activate a small zone of the liner to a comparatively high level was successful to a limited extent. Use of elaborate radiation detection equipment during engine tests would have made it possible to discriminate wear occurring in that zone. However, this has not been attempted yet.

Substantial amounts of manganese 54 were distributed in the shielded and unshielded zones of the liner. The 300-day half-life of this isotope results in a liner with a useful radioactive life of years, compared with that of months usually obtained for piston rings—normally activated in a way that leads to the production of the shorter-lived iron 59 and chromium 51.

The radiation hazard involved in installing the liner in an engine was investigated. It was apparent that no single operator would receive the maximum permissible exposure of 300 mR per week if care was taken to use different people for different operations. Use of remote handling equipment was considered unnecessary. While it would decrease the dosage rate, the increase in time brought about by the remote handling procedure would result in an overall increase in cumulative dosage.

The liner was transported in a lead container from Battelle Institute, Columbus, Ohio, to the Beloit factory of Fairbanks and Morse by lorry. Normal production operations of jacketing, water testing, honing, and bore checking were all performed by production personnel with normal equipment. Installation of the radioactive liner and engine build-up were completed in three 8-hour shifts.

An important requirement of the experiments was the detection of all the irradiated cylinder material debris, as there was no way of knowing what percentage would go to the lubricating oil sump and what percentage would be discharged with exhaust gases. Throughout the experiment, lubricating oil and exhaust gas samples were collected for analysis at 6 to 16 hour intervals. The accuracy of the radioactive-tracer method was checked by comparing its measure of gross wear with wear as determined by use of a bore-gauge micrometer. Four diameters of the cylinder were measured at eight elevations before and after each test, the readings being averaged at each elevation to determine the total volume of material removed.

TESTING THE OIL

Two methods were investigated for the radio-assay of the lubricating oil. The first involved removing and concentrating the wear debris—only limited success was achieved because of the difficulty of obtaining a uniform separation of a high fraction of the debris. The second method, which was selected as the most suitable, was to analyse the untreated lubricating oil directly, using an immersion detector of the scintillation type.

Exhaust gas analysis was carried out by filtering a sample of the gas through glass fibre mats. Debris was reduced chemically for assay in a well counter. This method was necessary because of the limited capacity of the existing equipment. To handle the large number of samples expected during future tests, a scintillation well counter big enough for direct counting of the exhaust filter mats will be provided

The results of initial tests show that an accuracy of about 5 per cent can be achieved with the new technique. It seems likely that information previously unobtainable will now be determined easily, quickly, and relatively inexpensively—such things as the effect on cylinder wear of starting, idle, or cold operation, of sudden load changes, speed, torque, etc. Simultaneous data can be obtained on rings and other wearing parts by use of different isotopes and pulse height analysis. Local areas of the cylinder may be monitored by selective irradiation in conjunction with pulse height analysis. Fairbanks, Morse and Company are expanding their equipment facilities and acquiring a more highly irradiated cylinder. Further tests will be carried out in the near future.

Metal Whiskers Cause Electrical Breakdown

It is fairly well known that the theoretical strength of a metal is always much greater than the practical strength. This is because metal crystals contain centres of weakness known as dislocations which allow plastic flow to occur at low values of shear stress. By eliminating these dislocations, it would be possible to make a material, such as lead, stronger than the best known alloy steels.

Modern theory suggests that if a metal crystal contains no dislocations it is very strong, but if a few dislocations are present it is very weak. However, if a high concentration of dislocations are induced by, say, cold working or neutron bombardment, then the strength increases because the dislocations interact with each other and their free movement throughout the crystal is impeded.

In an article on metallurgical research, recently published in the Siemens Edison Swan *Journal*, No. 3, vol. 1, Dr. J. E. Hughes of Associated Electrical Industries points out that confirmation of these theories has, rather surprisingly, come from the electronics industry in the form of metal "whiskers." These whiskers which, according to Dr. Hughes, were first discovered as minute single crystal filamentary growths in some types of telephone equipment, were at first considered a nuisance because they grew through certain insulating materials and caused short circuits to occur. However, close examination of their properties has shown them to exhibit a very high degree of crystal perfection with little or no dislocations which, in turn, means that they possess shear strengths approaching theoretical values.

While these minute metal whiskers have only academic value at the moment it is quite possible that techniques will be developed in the not too far distant future for their commercial exploitation.

However, at the moment they are still a possible source of breakdown in electronic components and for this reason metals such as cadmium, tin and zinc, which are susceptible to crystal growth, are no longer used where the growth of whiskers could cause short circuits. An example of this is to be seen in submarine repeaters, where components are gold plated to prevent whisker growth.

High strength tin "whiskers," grown from a tin-aluminium alloy at the AEI Research Laboratory.

Flow of Granules Through Apertures

The analysis of the flow of granules through apertures requires an adequate kinematic account of the way in which the granules emerge.

If $n(x)dA$ is the number of granules passing an elementary area dA, distant x from the edge of, and in the same plane as, an aperature, it is proposed, for slits and circles, that $n(x)$ does not depend on the size or shape of the aperture.

This important kinematical hypothesis, relating the size and shape of an aperture to the number of granules passing through it, was given in a paper entitled " Profile of Flow of Granules Through Apertures," presented at a meeting of the Institution of Chemical Engineers by R. L. Brown and J. C. Richards on 22 March. The authors are with the British Coal Utilization Research Association.

The manner in which the rate of flow of granules, ndA, varies across the aperture is called the number profile. The authors' hypothesis states: " The number profile develops from the edge of the aperture and is independent of its size and shape." Unsymmetrical shapes are not, as yet, included. The only shapes so far examined have been slits and circles.

It is shown that there is a statistically empty space adjacent to the edge of the aperture and that the width designated $\frac{k}{2}$ of the annulus so formed does not depend on either the size or shape of the aperture. Thus the effective diameter of a circular aperture, of diameter D cm, becomes $(D-k)$ cm. This empty space is related to the dimension of the aperture which would be blocked by the granules. This bears out the suggestion made in an earlier study* that the size of the " blocked aperture " is one of the determining factors for the rate of flow of granules through larger apertures.

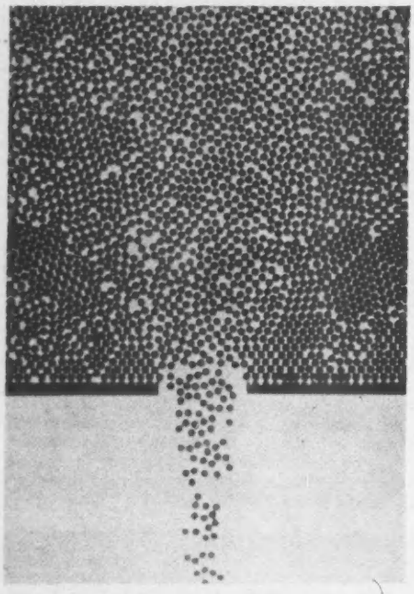


Fig. 1 The flow of a single layer of granules through an aperture clearly shows the statistically empty regions at the edges.

Brown and Richards have shown that their hypothesis enables rates of flow through circular apertures to be derived from those measured through long slits. Since their earlier study had shown that the flow from a vessel was independent of its width unless this were less than $2\frac{1}{2}$ times the width of the aperture, their experiments were restricted to vessels in which this ratio was exceeded. Likewise, a slit length of 10 cm was considered long enough for end effects to be neglible, provided the slit overlapped the base of the container and was equivalent to an infinitely long rectangle.

The number profile has been shown to vary as the square root of the distance of the elementary area dA from the nearest point on the boundary of the statistically empty space.

SINGLE LAYER FLOW

In their preliminary investigations, Brown and Richards used a single-layer system of ball bearings moving down an inclined glass plate. This system lent itself to simple measurement relating to the kinematic hypothesis.

The " trumpet shaped region " above the aperture (see Fig. 1), within which the main movement of the granules takes place, is readily seen during the flow of a single layer of ball bearings down a slightly inclined glass plate. Observing the flow in silhouette, it can be seen that their movement inwards, toward the central axis, results in the balls falling only rarely through the space immediately adjacent to the edge of the aperture. This contraction continues below the aperture to a minimum cross-section of about 0·4 to 0·6 times that of the aperture. The ratio of the minimum cross-section to aperture width appears to decrease with increasing aperture size.

Films of the flowing ball bearings, taken at speeds up to 500 frames per second and projected at 16 frames per second, show dilatant waves passing continuously through the material in the trumpet shaped core. The balls move inwards, outwards and upwards, as well as downwards. By counting, in every 25th frame, the number of balls in an observation area (see Fig. 2), a picture of the fluctuating voidage is obtained (Fig. 3).

Evidently the waves are manifest as compression waves leading to tight packing but, when tight packing forms, it is relieved by the balls falling away successively from the underside. The voidage fluctuates from 15 per cent to 54 per cent, with a mean of 35 per cent.

If the sequence in Fig. 3 were random, the expected number of peaks and troughs would be 46, with a standard deviation of 3·5. The observed number, 32, differs significantly from 46. This statistical test is not very sensitive and a more detailed analysis is needed to confirm that the sequence is non-random, and to derive any possible systematic components. Visual observation suggests that the voidage across the aperture is somewhat higher than that above the aperture. It is apparent that the balls crossing the plane of the aperture are moving faster than those slightly above it.

Evidently the flow of balls is consequent upon their re-arrangement and so it must be associated with the action of the dilatant waves. It will be appreciated that the statistically empty space permits the re-arrangement near the aperture and it is, therefore, also associated with the dilatant waves. When a tight configuration happens near the aperture, it appears to correspond to incipient arch formation which quickly shifts to a new configuration.

NUMBER PROFILE

By using slow motion films, it has been possible to count the number of balls passing a 0·5 cm line during a period of 0·3 sec actual time. In this way the number of profiles for two apertures of 4·2 and 9·5 cm have been determined. These

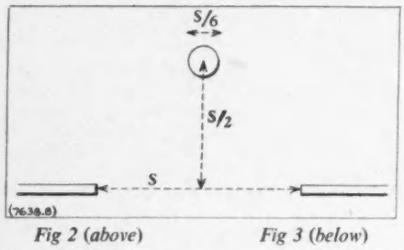


Fig 2 (above) *Fig 3 (below)*

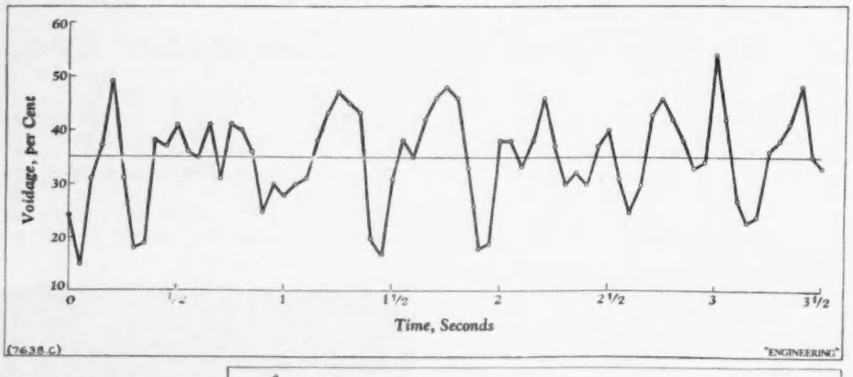


Fig. 2 Observation area for measurement of the fluctuating voidage, using a single layer of ball bearings of 0·52 cm diameter. S = 9·5 cm.

Fig. 3 Fluctuating voidage associated with dilatant waves in single layer, ball bearing flow.

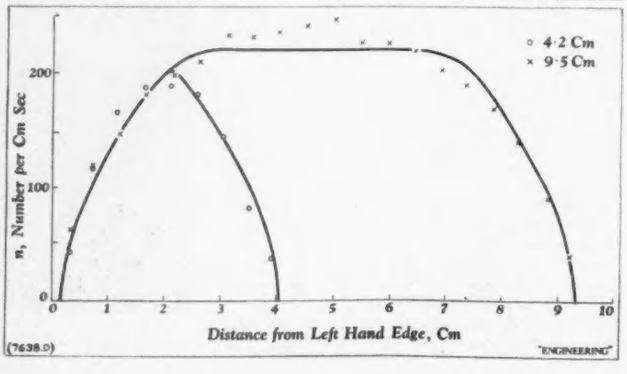


Fig. 4 (right) Number profile for two apertures, with a single layer of ball bearings.

* Brown, R. L., and Richards, J. C., *Transactions of Inst. Chem. Engs.*, vol. 37, London, 1959.

are shown in Fig. 4, where the ordinate is plotted at the mid-point of each of the 0·5 cm ranges, except for those two ranges adjacent to the edges of the aperture, where an empty space of 0·15 cm has been left.

It is clear that the number profile does not depend on the width of the aperture. It would appear that the profile develops from the two edges of the aperture and meets in the centre. This finding enables the number profile to be derived from the relationship between flow rate and aperture size.

If m is the mass of a ball (in grams), and $n(x)dx$ balls per cm sec pass the element dx, distant x from the edge of the aperture, then the flow $\frac{1}{2}$ Q through one half of the aperture is

$$\tfrac{1}{2}Q = m\int_0^{\frac{S}{2}} n(x)\,dx, \quad \text{whence} \quad \frac{dQ}{dS} = mn\left(\frac{S}{2}\right).$$

This differentiation is permissible since $n(x)$ does not depend on the width of the aperture. The curves (plotted from the edges and meeting in the centre) shown in Fig. 4 were found in this way. The agreement with the count is clearly very good.

The rolling and sliding of balls through a single layer is discernably different from that of a granular mass in a pipe or bunker. Irregularly shaped granules cannot pack together in the relatively ordered tight configuration that is possible with equally sized balls. Air can enter or leave a granular bed in a bunker from the top or through the aperture, whereas the voids in a single layer are everywhere accessible to air. Although it would be unreasonable to suppose that dilatant waves do not play a part in the flow of a normal granular system, these two considerations indicate that their effect may not be equal in the two cases.

FLOW-RATE CALCULATION

In addition to their investigations into single layer granular flow, Brown and Richards have predicted the flow rate of several different materials through circular apertures from a knowledge of their flow rate through slits.

The results are given in the table for the largest, median and least values of the diameter D, lying within the range of the slit data. Bearing in mind the fact that all the errors in the slit data can accumulate when making the integration, the agreement of the calculated and observed values is fair. Repeat tests show that the observed flow rates may be $\pm$ 1 unit out in the second significant figure quoted.

It appears that the hypothesis stating that the number profile depends only on the distance from the edge of the aperture, being independent of its size and shape, is a good first approximation. It may be expected to hold for symmetrical apertures but, in some unsymmetrical apertures, rigorous application of the hypothesis might lead to discontinuities in the profile.

In concluding the presentation of their paper, Brown and Richards point out that the width of the empty annulus must be subtracted from the aperture size in order to determine the effective size of the aperture for flow. Twice the width of the empty annulus corresponds to the width of the " blocked slit " and this in turn is about half that of the " blocked circle." Lastly, it appears that, for several materials, the number profile follows a square root relationship with distance from the edge of the empty annulus, at least for sufficiently small apertures.

TABLE—*Comparison of Observed Flow Rates through Circles with those Calculated from Slit Data*

Material	D (cm)	Flow rate, gm per sec.		
		Observed	Calculated	Δ Q
Beads (B1) ..	0·394*	1·0	1·0	0·0
(B2) ..	0·500	5·1	5·5	−0·4
	0·348	1·7	2·0	−0·3
	0·140	0·12	0·12	0·0
Sand (X) ..	0·660	5·8	5·6	0·2
	0·475	2·1	2·1	0·0
	0·348	0·79	0·73	0·06
(Y1) ..	0·615	4·0	3·7	0·3
	0·500	2·1	1·9	0·2
	0·475	1·6	1·6	0·0
(Y2) ..	0·772	8·9	9·2	−0·3
	0·500	2·7	2·7	0·0
	0·348	0·86	0·86	0·0
(Y3) ..	0·564	4·4	4·0	0·4
	0·462	2·5	2·3	0·2
	0·348	1·1	1·1	0·0
Coal	0·772	3·6	3·6	0·0
	0·615	1·8	1·8	0·0
	0·500	0·94	0·89	0·05

* Flow induced by continual tapping.

Evaluation of Thin-Film Resistors

Thin metallic films have long been considered as an ideal basis for making precision variable resistors. Compared with other techniques, they have many advantages: resistance range, accuracy, stability, achievement of complex functions, and in some cases, cost.

Such resistors have been prepared from transition-metal alloys, precious or noble metal alloys, carbon and borocarbon, two oxides and a nitride. The extent to which any material can be used successfully in a thin film potentiometer (variable resistor) depends upon its own fundamental properties; and of course careful evaluation of such properties is essential before any material can be accepted for use in this respect.

When considering any new potentiometer techniques, designers and manufacturers must consider electrical and physical properties as well as ease of installation and cost. However, according to a report in the February, 1960, issue of the *Battelle Technical Review*, published by the Battelle Memorial Institute, Ohio, USA, a wider range of features of film and moving contact combinations are important in determining the ability of various film materials to give overall satisfaction as potentiometers. Primarily these are: film material; method of electroding to the film; the base on which the film is supported; and contact material.

To evaluate the suitability of film-type materials for potentiometer applications, the Battelle report suggests that the following measurements or observations be made: examination of surfaces using light or electron microscopy; linearity; resolution; contact and noise resistance; effect of shorting by moving contact; film resistance, temperature coefficient of resistance, and voltage coefficient of resistance; effects of wear; effects of various environmental conditions (e.g., humidity).

Through such evaluations, and with the development of operating units, states the report, the potential advantages of film-type variable resistors may be realised eventually and, thereby, lead to the advancement of electronic systems.

High-Speed Electromechanical Switch

A very fast electromechanical switch, using an entirely new technique for its actuation, has been developed at the Bell Telephone Laboratories in the USA. Known as a " ferreed," its speed is comparable with that of an electronic switching circuit. If used as an interconnecting element in telephone switching networks it could be controlled a thousand times more rapidly than the devices commonly employed at the moment.

The ferreed combines the rapid switching of a bistable magnetic material with metallic contacts for output indications that persist as long as desired without further application of power. In several models of the device, a cobalt ferrite has been used as the magnetic material and a glass-sealed magnetic reed switch for the output contacts—hence the name, ferreed.

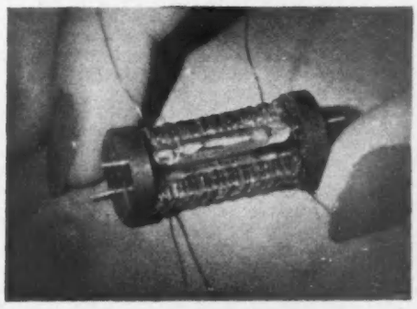
In operation, the magnetic material is switched by a magnetomotive force applied, typically, as a five ampere current pulse in a thirty-turn winding. Control pulses as short as five microseconds will switch the magnetic material, resulting in the passage of magnetic flux through the movable members of the reed switch. Actual closure of the contacts is delayed by the inertia of the reeds for several hundred microseconds.

Release of the contacts is brought about by cancellation of the magnetic flux through the reeds, as the result of another five microsecond switching operation. Opening of the contacts requires less time than closing.

Several new magnetic materials have been synthesised for use in development models of the ferreed. Among these are ferrites exhibiting characteristics midway between permanent magnets and computer memory materials, and ferrite suspensions in a plastic material. The reed switch is largely similar to present-day types in common use.

In a telephone switching network, subscribers are interconnected by the closure, in specified patterns, of switches. Many thousands of these may be contained in a typical central exchange. The switch-points required for a particular connection must be selected by the coincidence of pairs of control pulses. The ferreed's magnetic structure responds to a pair of pulses by closing the output contacts. They are opened by subsequent single pulses.

Besides coincident pulse operation and rapid actuation, the ferreed's magnetic structure permits the desired switching by current pulses of widely variable character. This means that, when a ferreed is used in a switching network, it will be capable of giving reliable operation from a simple control circuit.



Known as a " ferreed," this new electromechanical switch makes use of ferrite bars and magnetic reed switches to produce a device that can be controlled by pulses of only 5 microsecond duration.

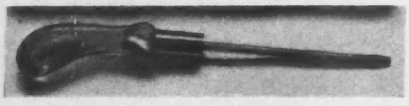
Home Work Increases

With an annual expenditure on materials of over £200 million, do-it-yourself is definitely in the realm of big business. Its growth has been phenomenal but is vitally linked to costs. For example, a reduction in hire purchase restrictions resulted in a fall in the sale of furniture kits. This would appear to suggest that do-it-yourself is born more of the pocket than of the will.

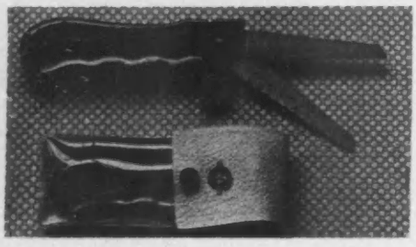
At least five manufacturers make complete home "workshops" based on small electric drills. The drills can be mounted on vertical stands, they can be mounted on horizontal stands for use as lathes, attachments include saws, planers, moulders, dovetailers, sanding drums, dowelling kits, jigsaws, paint stirrers, as well as grinders and polishers. They cover, in fact, very nearly every tool wanted for most woodworking jobs and for many metal ones too, not forgetting the hedge trimmer, grass cutter and insecticide sprayer for the gardener.

A tool recently added to the Surform range is a drum cutter for attaching to a drill. The drum is a circular version of the Surform cutter, of 2 in dia, for planing, shaping, bevelling, and rebating wood. It can be used with the drill held in the hand or fixed on a stand. For use with the drum the firm are making a planing and rebating attachment which enables rebates up to $\frac{3}{4}$ in by $\frac{3}{4}$ in to be cut quickly and accurately.

The attachment consists of two adjustable plates which control the width and depth of the rebate. The plates are marked off in $\frac{1}{8}$ in divisions. When used for planing the depth control plate is set at its shallowest level and the width control plate removed.



The Steadfast ratchet screwdriver has a plastics handle made in a pistol grip shape.



Also new to the Steadfast range is a plastic handled pad saw.

A new ratchet screwdriver in the Steadfast range has a clear amber plastic handle in a form approaching a pistol grip. The angular shape allows the operator to exert very great force even when working on only a single tooth of the ratchet. It also fits the hand well. This grade of plastic is virtually unbreakable; it is being used for the handles of chisels and enables hammers to be used (in place of mallets) without fear of damage. The blade of the screwdriver is 6 in long and the ratchet can be set for either direction or locked in the mid-position. More recently still, Steadfast have introduced a pad saw, also with an amber plastic handle. There are two saw blades and a knife-edge cutter, which all fold back into the handle when not in use. A wing nut clamps them in position. The handle is shaped to give a grip for the fingers and the whole tool is supplied in a plastic wallet. Spare blades are available.

At the beginning of the year Steadfast brought out a range of flexible high speed hacksaw blades. There are two sizes, 10 in or 12 in long. Both are available with teeth of 18, 24 or 32 pitch and the latter has in addition a choice of 14 in pitch. By virtue of the fact that only the teeth are hardened, the blades are far more flexible than other types, resulting in fewer breakages.

An improved version of the Stanley trimming knife has a greater versatility due to the wider selection of blades available. Instead of the five normal duty blades supplied for the earlier type, there are now three normal duty, one heavy duty and one hooked blade included. They are carried in the handle together with a blade guard.

The handle has been made of a heavier alloy making the knife steadier, and a hole in the handle can be used for hanging the knife up. The securing screw has been made captive with the great advantage that it cannot be lost. All the blades are double ended.

A simple tool with great possibilities is the Pickavent Eva-Smooth file for use with abrasive tape or glass paper. As can be seen from the illustration, the body of the tool is a metal bar, shaped to give a handle at one end, and fitted with clamps. A roll of abrasive tape is held on a spindle below the handle and the end passes through a clamp and along the underside of the body to the front, where it loops back to be held by the second clamp. As the abrasive is worn out, the strip is pulled forward to bring a fresh section into use.

Heavy duty versions and hooked blades are now available for the Stanley trimming knife.

A roll of abrasive tape offers quick replacement on the Eva-Smooth file.

Dafiles are piercing saw blades with circular cross section and teeth all round. They have been available for some while in medium large sizes, but a new series—the FlexiFile—is now on the market. Two versions are made, of different diameter, the smaller making a cut about 0·019 in wide and the larger one about 0·030 in wide. Both can be used in such materials as acrylic plastics, ebonite, aluminium, hardboard and plaster of Paris, as well as such unlikely materials as foam rubber and cork. Type No. 1 (the smaller) can also be used on mild steel, duraluminin, copper, gold and silver. The files are available in two lengths of 12 in and 36 in. They can be used in any standard piercing saw frame.

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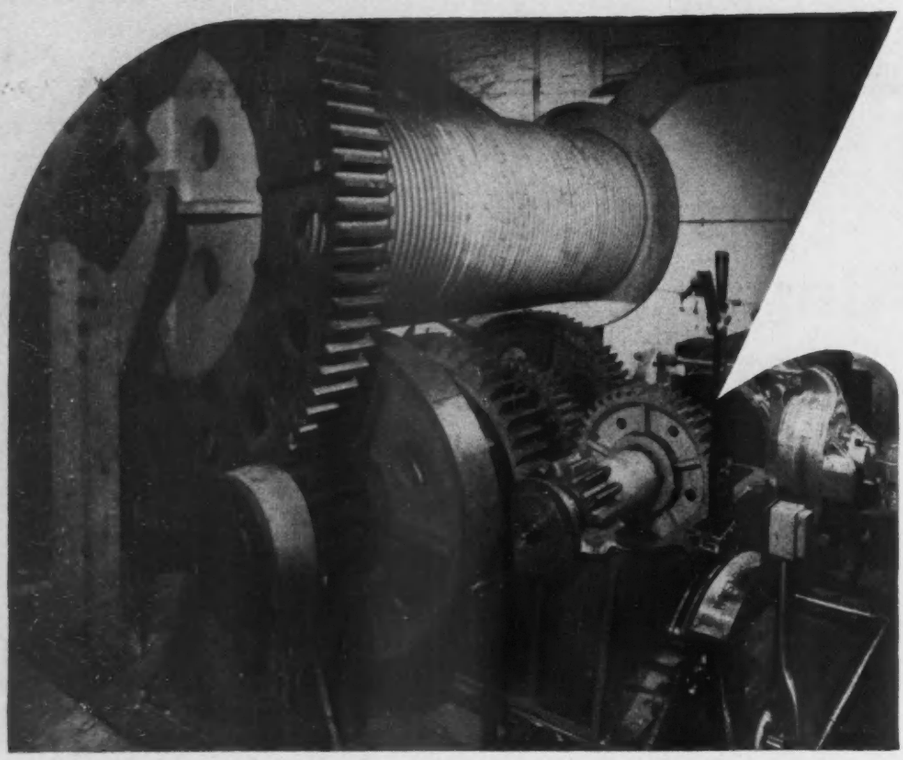

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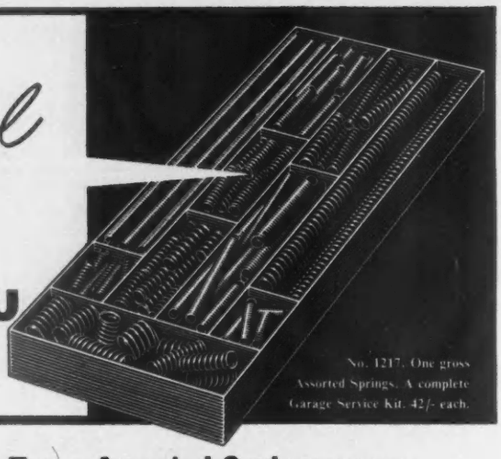

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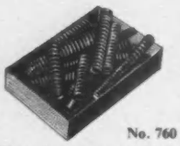

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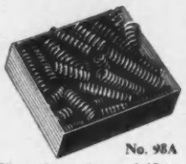

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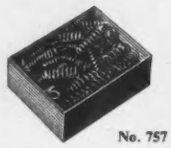

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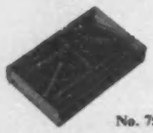

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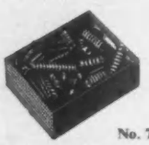

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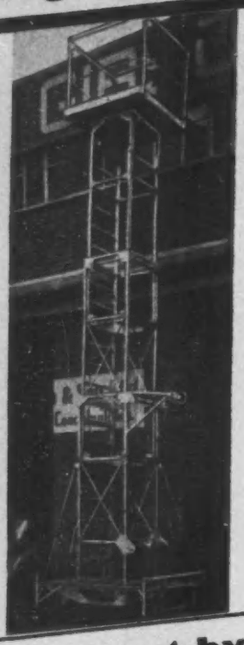

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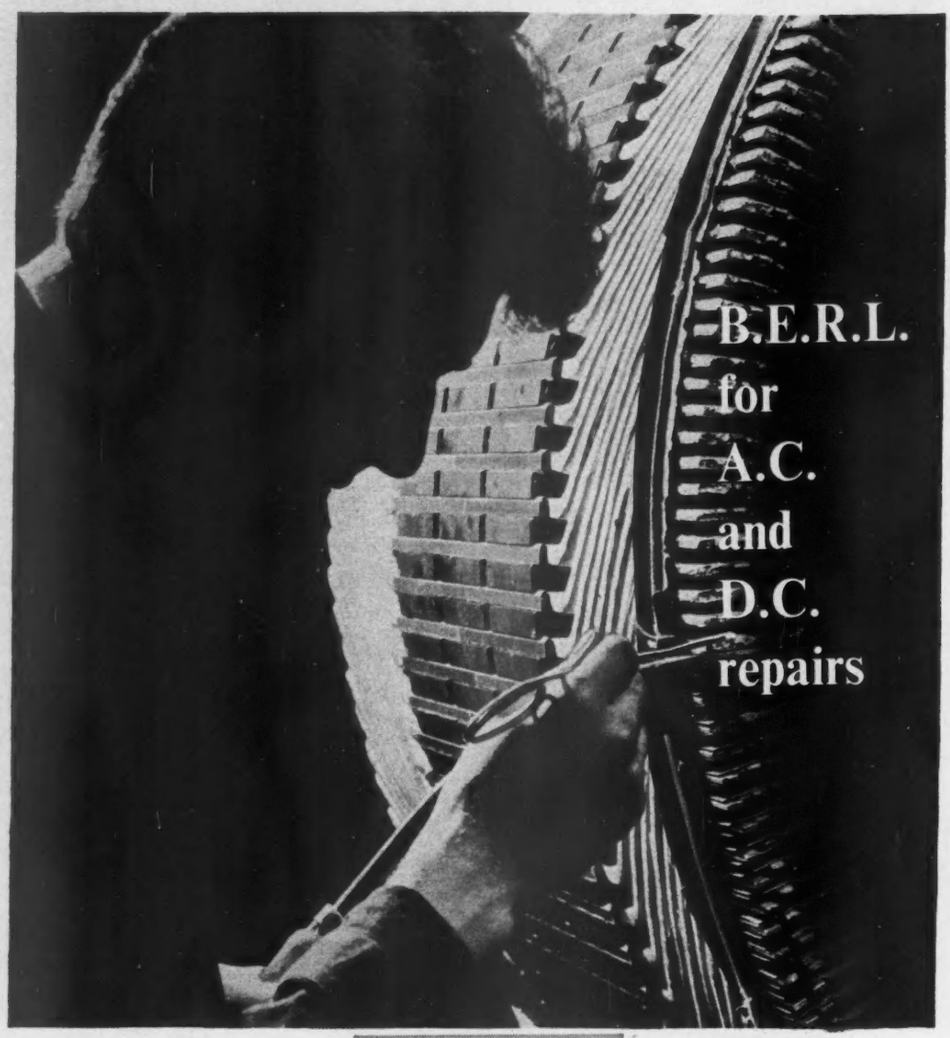

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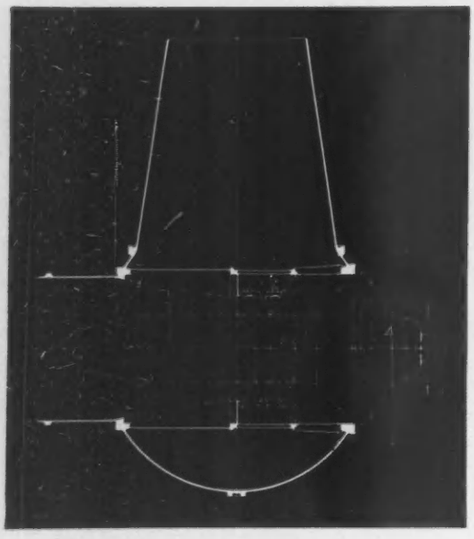

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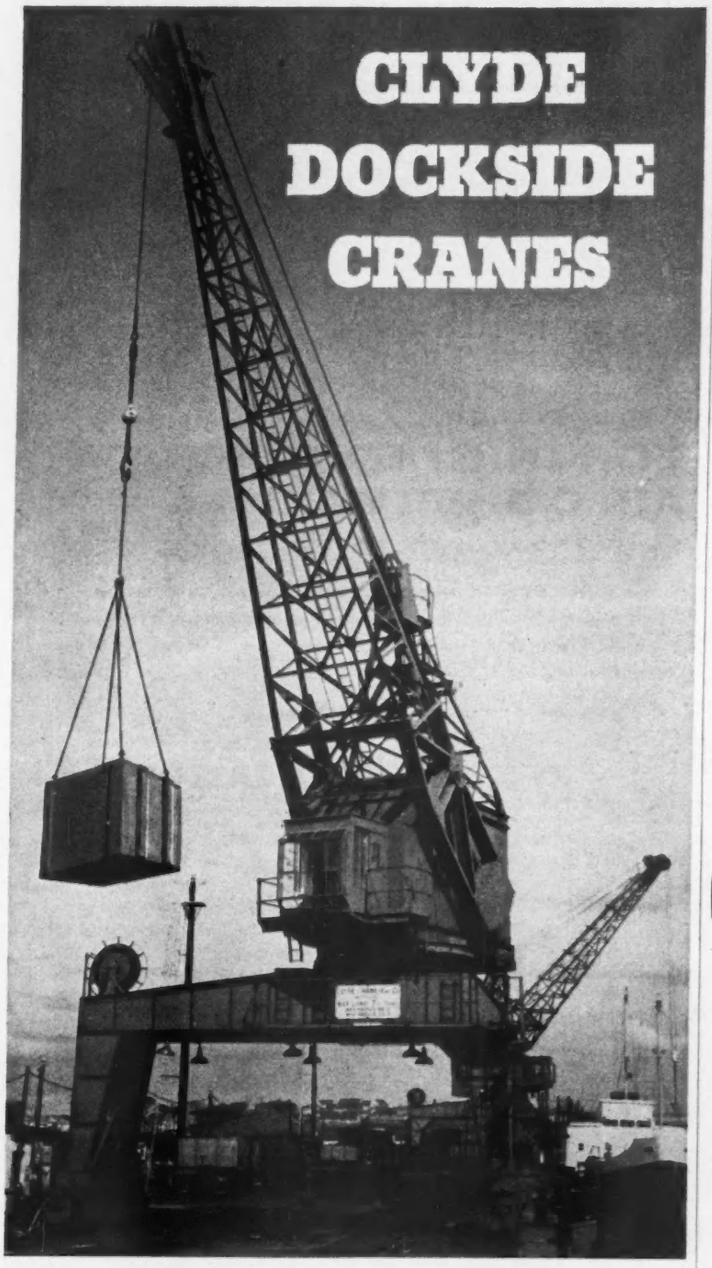

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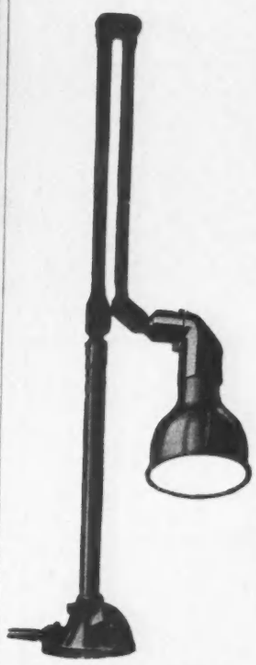

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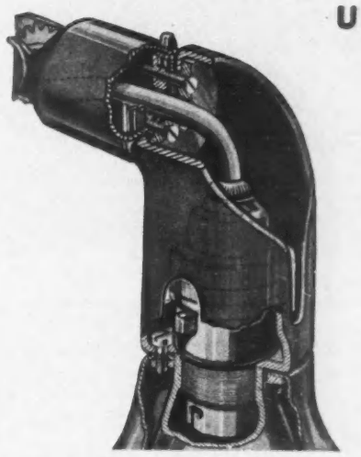

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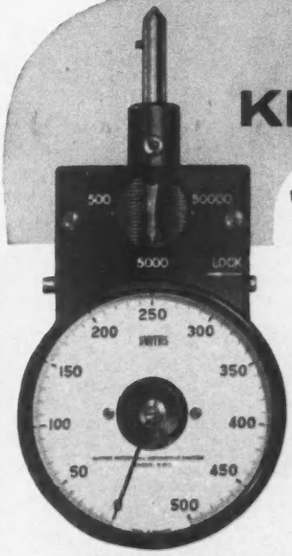

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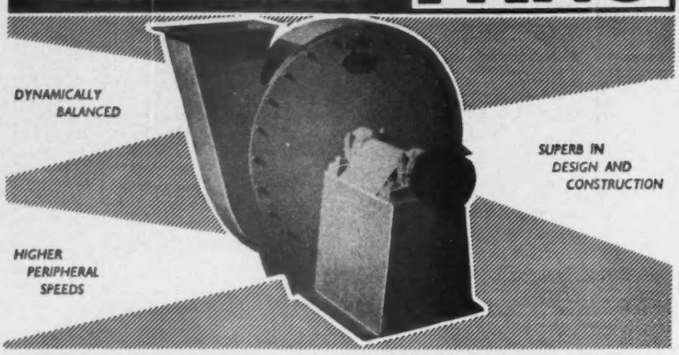

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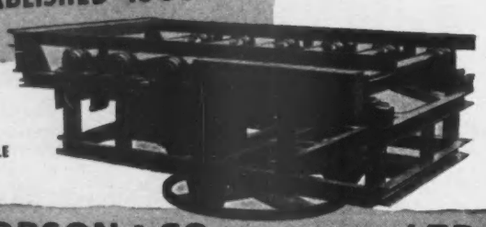

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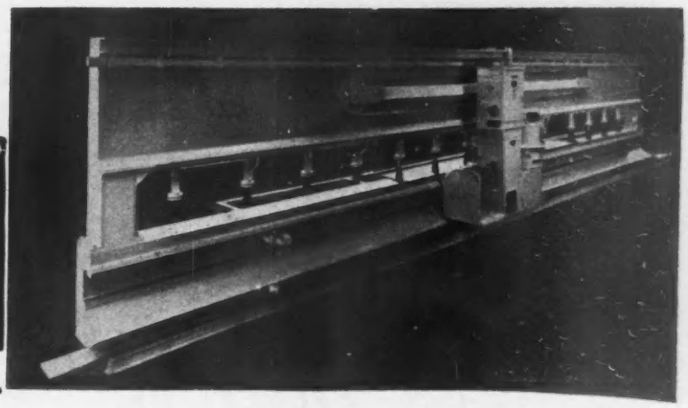
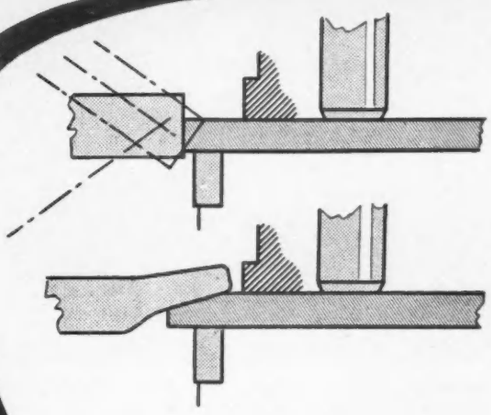
PLATE EDGE PLANING AND ROTARY SHEARING



JACK TYPE CLAMPING MACHINE



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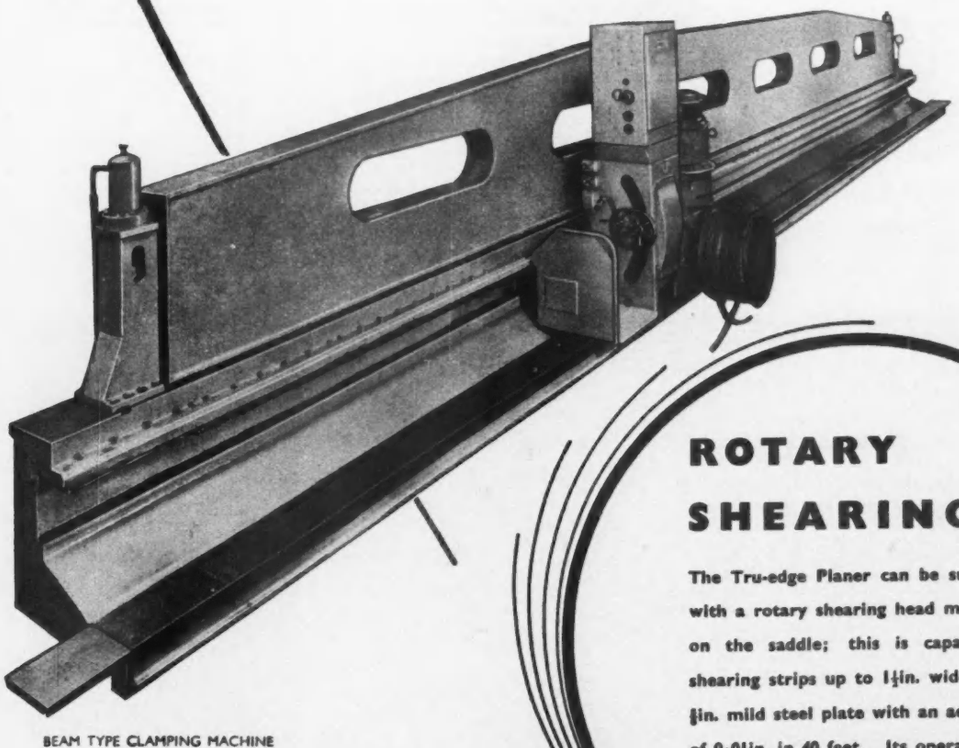
HUGH SMITH TRU-EDGE PLANER

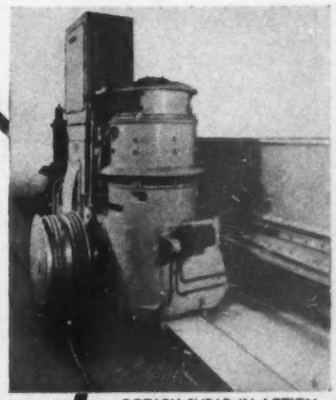
This planer, made in lengths of 25, 30, 35 and 40 feet, handles plates up to 2in. thick with speed and accuracy, and where thicker plates, or bundles of plates require edge planing we can provide a motorised tool box with a vertical rise of 6in. for progressive planing. Profile tools can be used in either case, or swivelling action can be provided for planing top and bottom bevels up to 35 deg. above or below the centre line. A special planing tool is available for cutting long bevels. In design and construction the Tru-edge Planer is highly modern in every respect and it will provide many years of excellent service. We will be pleased to supply technical information.



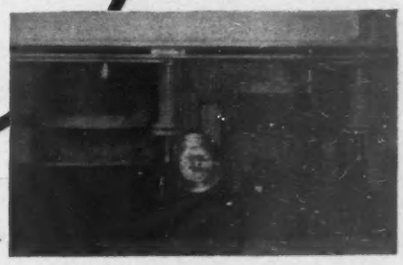
BEAM TYPE CLAMPING MACHINE

ROTARY SHEARING

The Tru-edge Planer can be supplied with a rotary shearing head mounted on the saddle; this is capable of shearing strips up to 1¼in. wide from ⅜in. mild steel plate with an accuracy of 0·01in. in 40 feet. Its operation is about forty times faster than gas cutting, and less expensive.



ROTARY SHEAR IN ACTION



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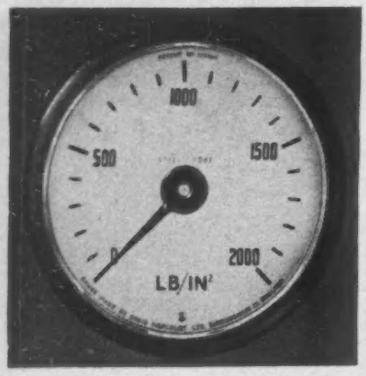

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This patented unit is recommended for the more important installations. It is available with four mountings as illustrated below with 4in. and 6in. diameter dials.
Large illustration and 2.
Narrow flange, with rear clamp fixing.
This model has a black, shock-resisting plastic case.
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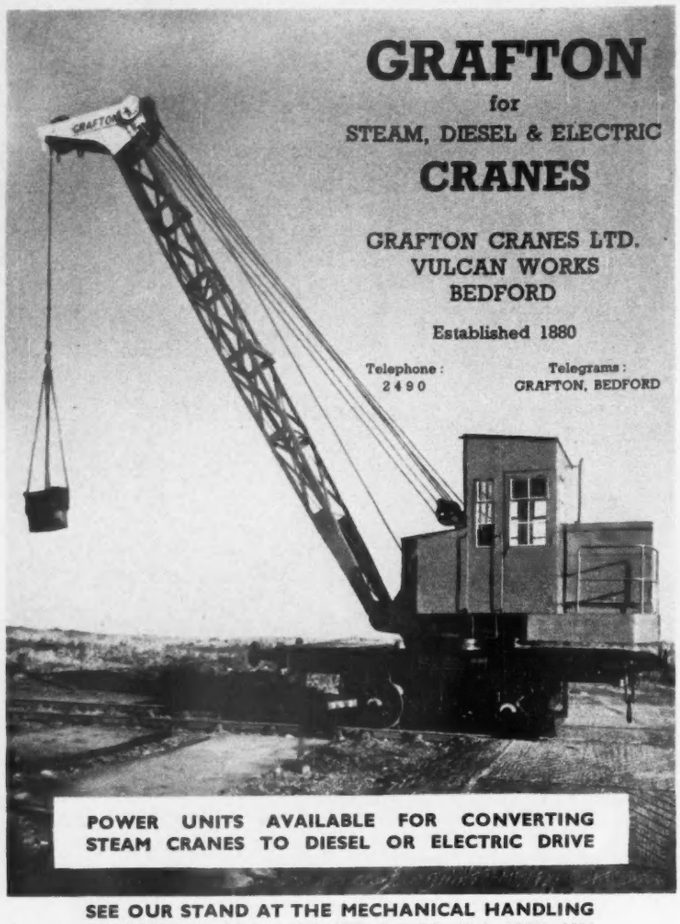

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Constructed by YARROW to the order of the United Africa Company for services on the Niger and Benue Rivers, West Africa.
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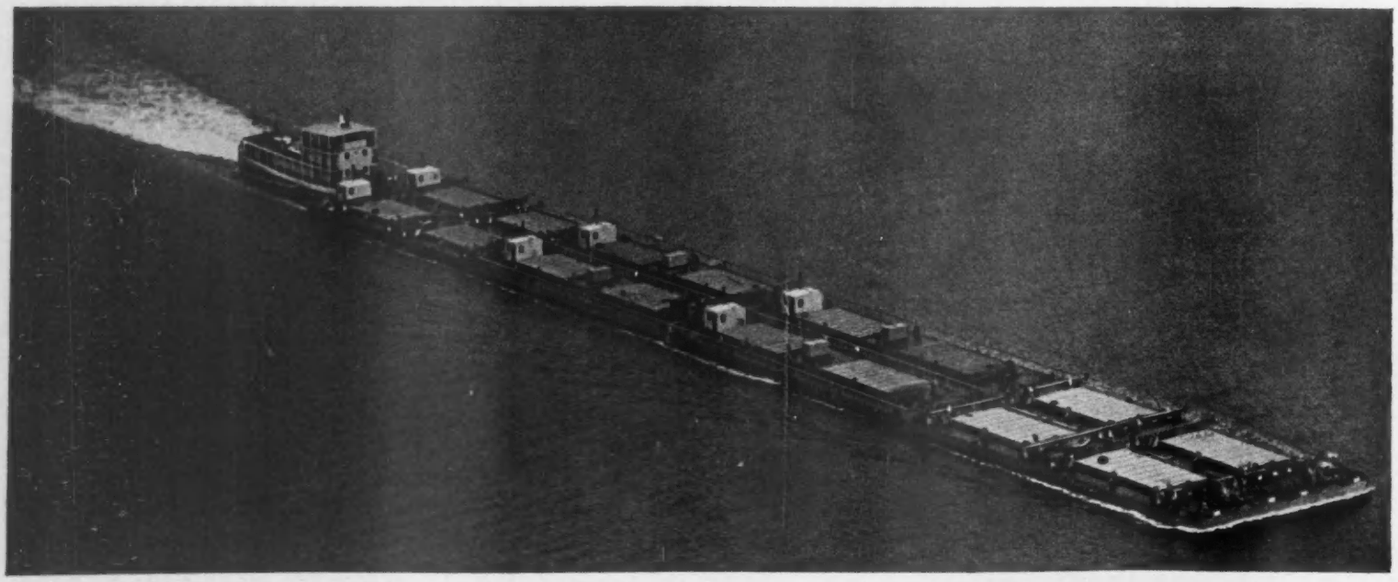

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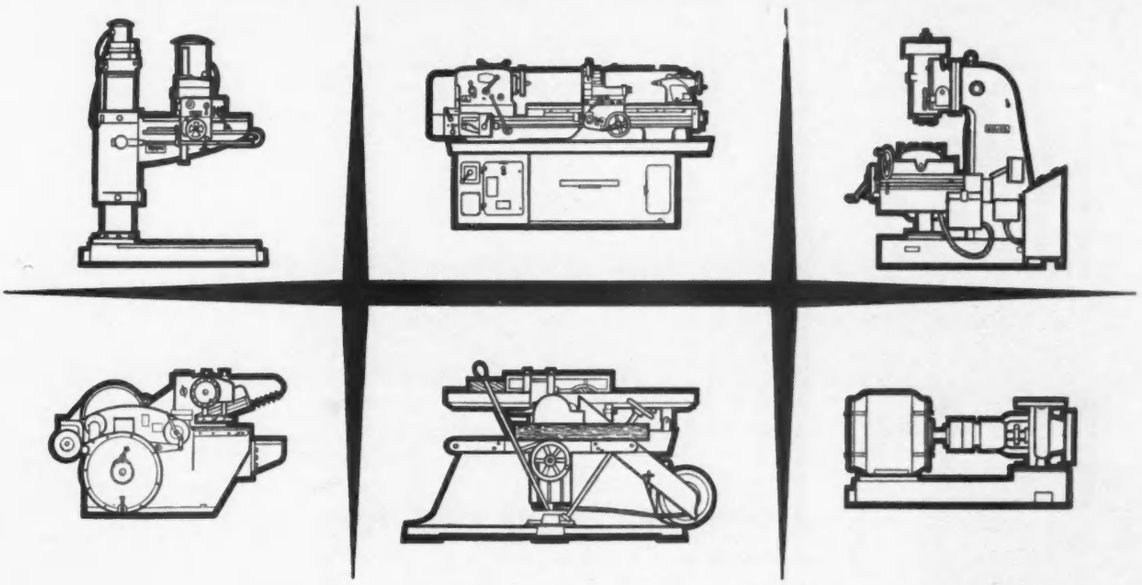

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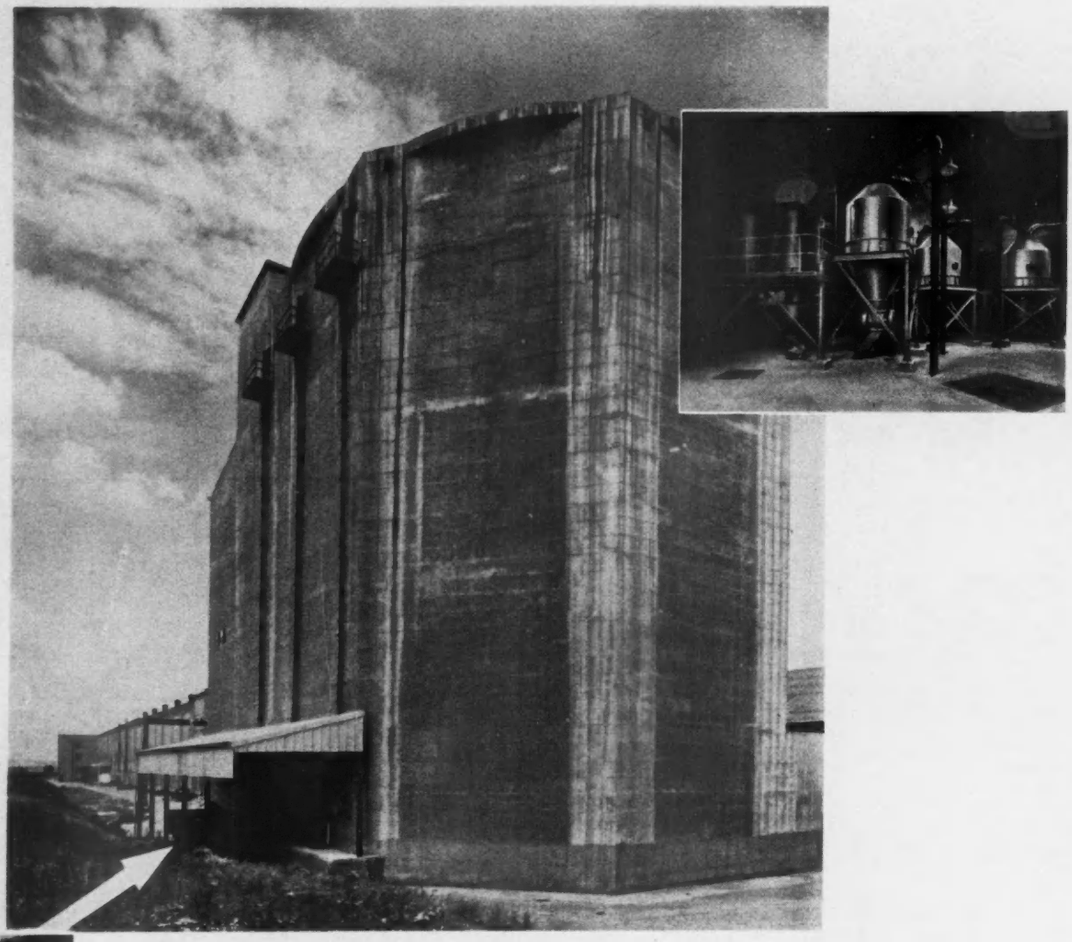

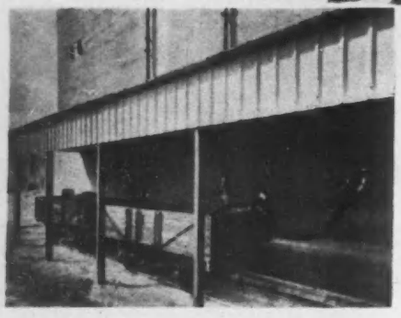

Three Sturtevant conveying pipe lines and inset (right) part of the receiving and separating sections. The Sturtevant plants unload bulk material from railway wagons and convey to the top of the building.

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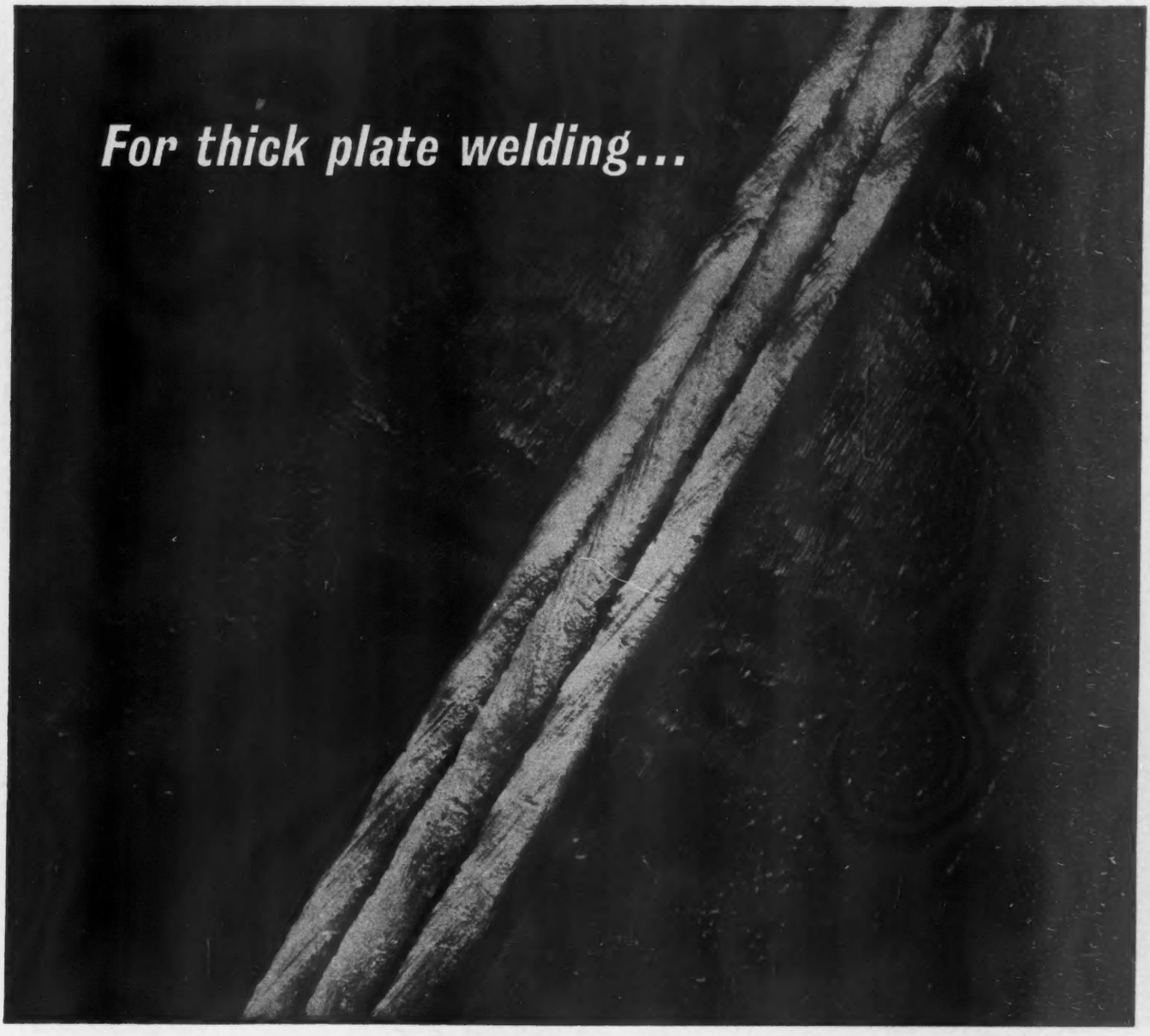
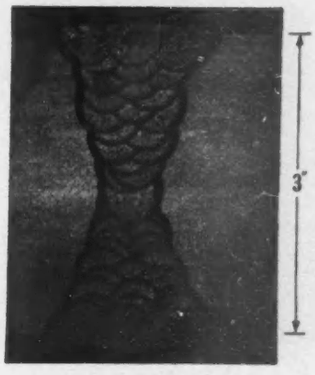


Murex "Muraflux A"

submerged-arc welding flux



High quality is essential in the weld metal of thick plate for nuclear power vessels and similar applications. This high quality can now be obtained by automatic methods, using the new " Muraflux A " granular flux and the submerged-arc process. Excellent Charpy impact results at sub-zero temperatures and good elongation figures in welds in 3-inch thick steel plate can be produced by using " Muraflux A " with Murex " Murawire W2." The ultimate tensile strength of the weld metal matches that of the parent plate and its radiographic quality is sound.

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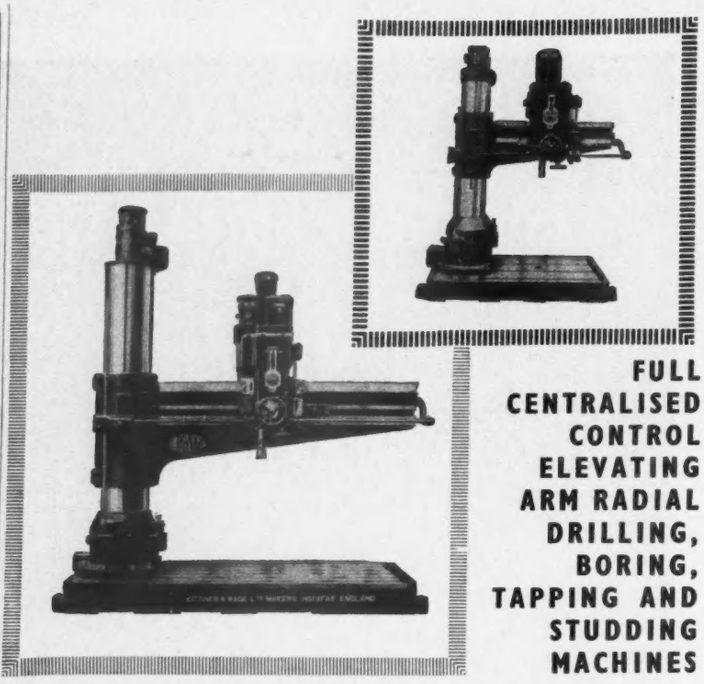

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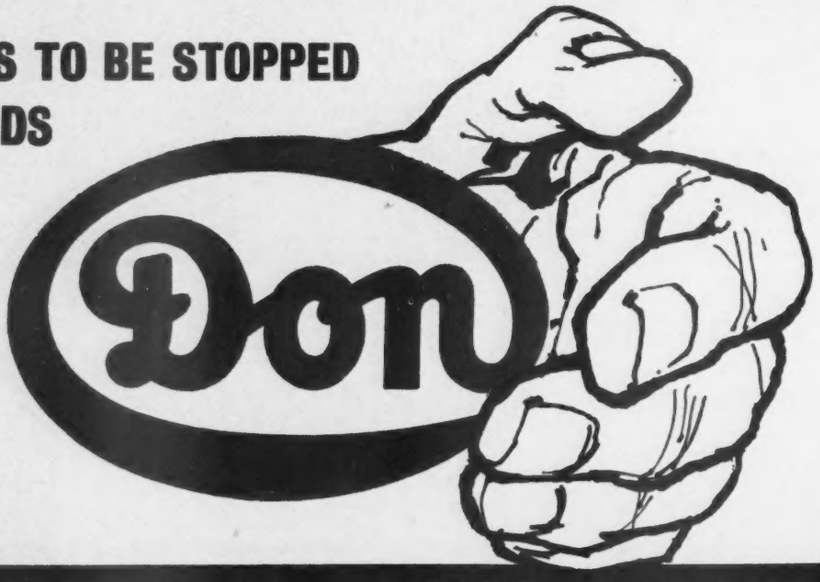

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from 3″ size upwards

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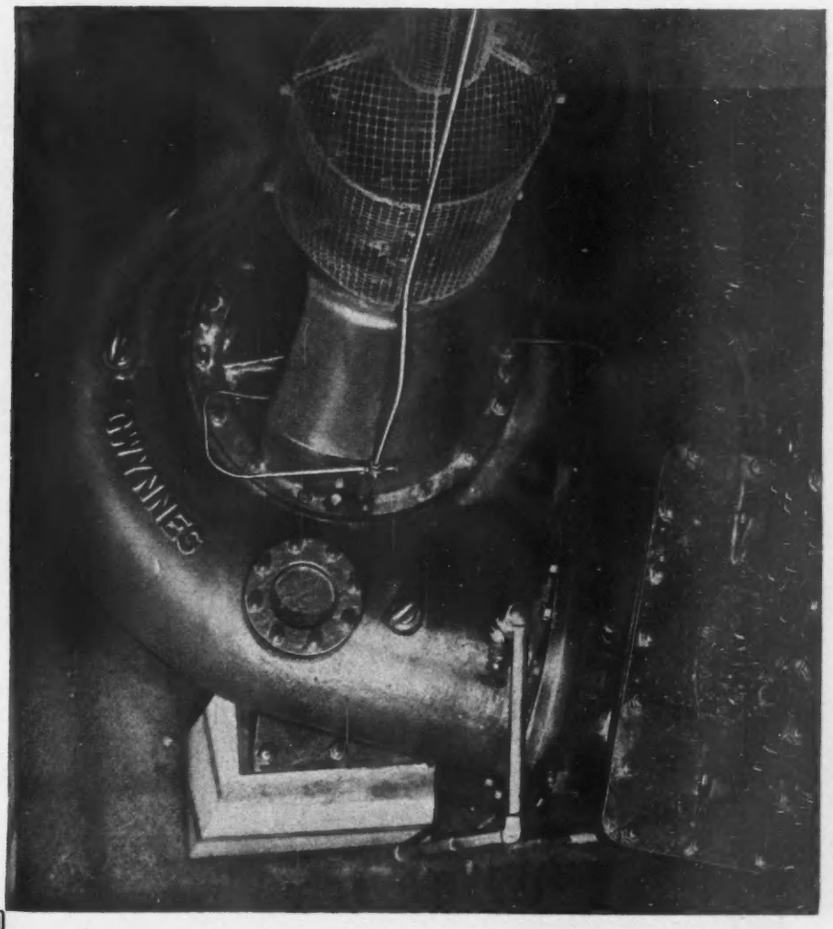

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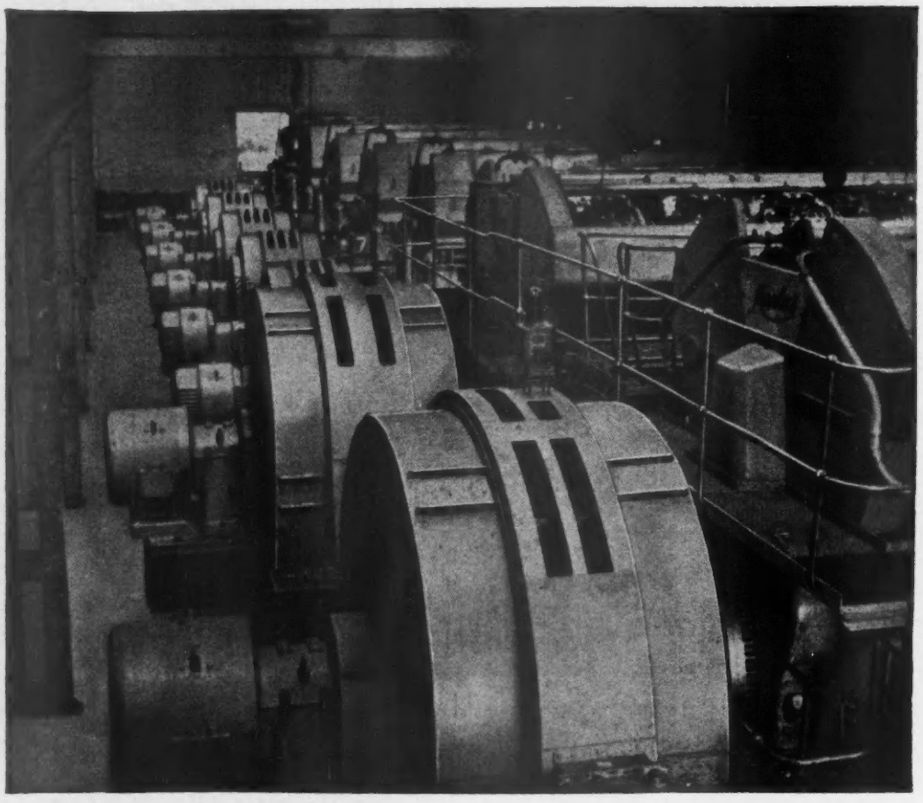

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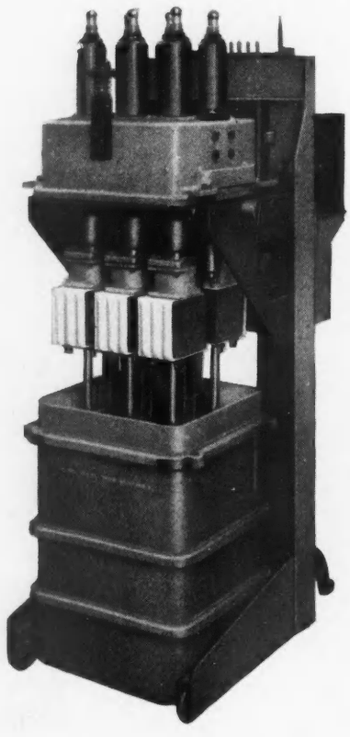

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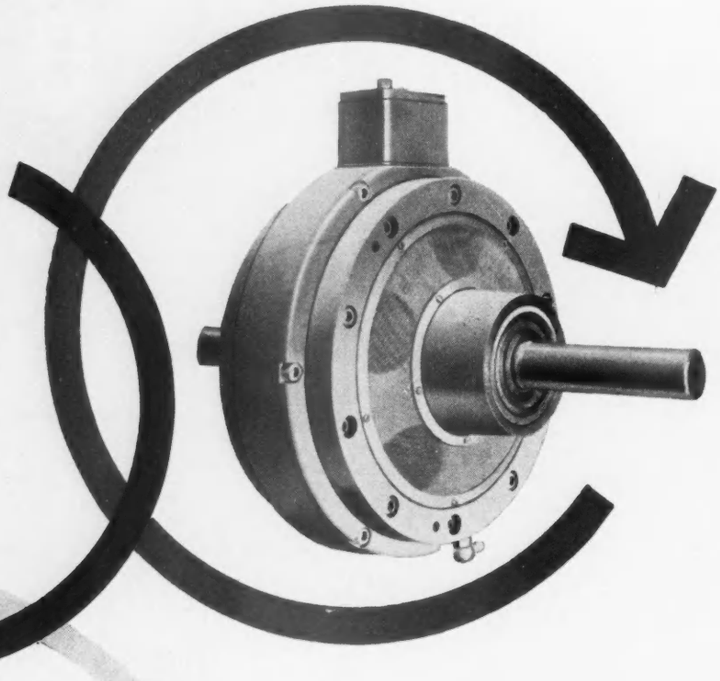

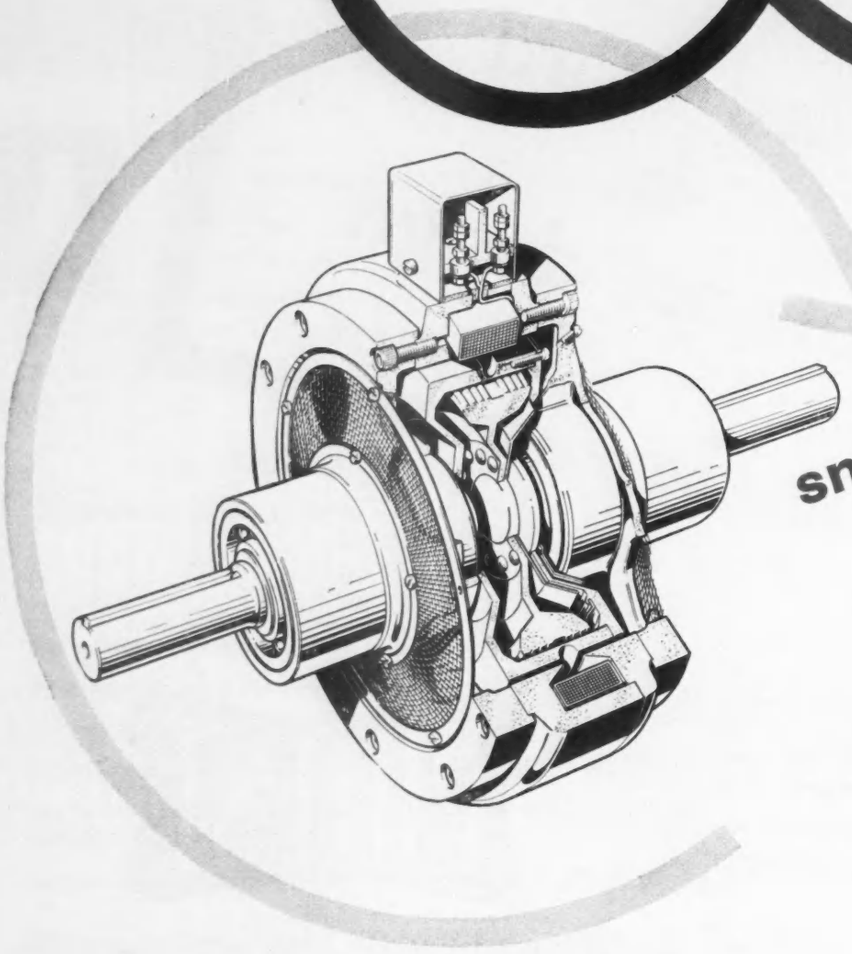

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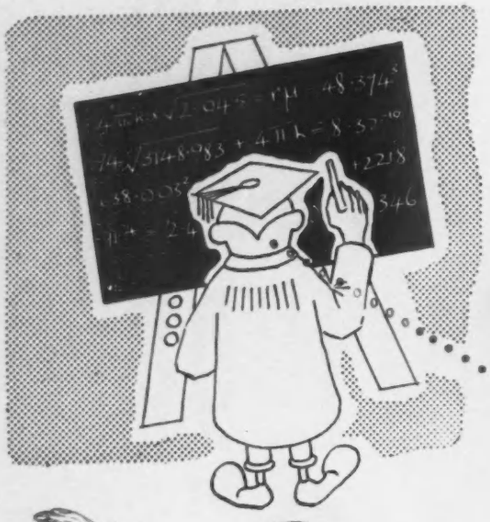

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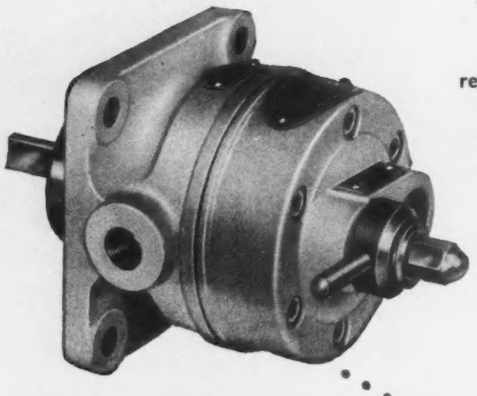

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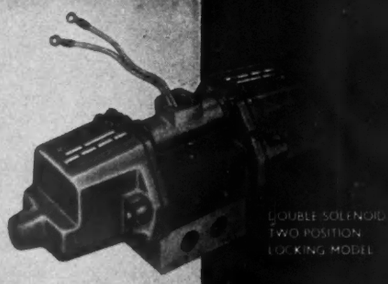

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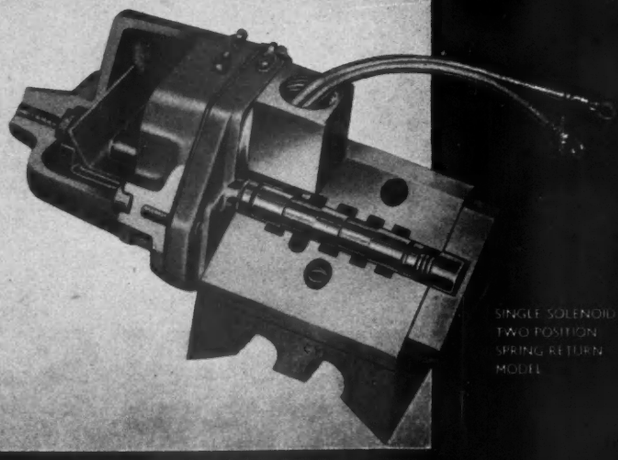

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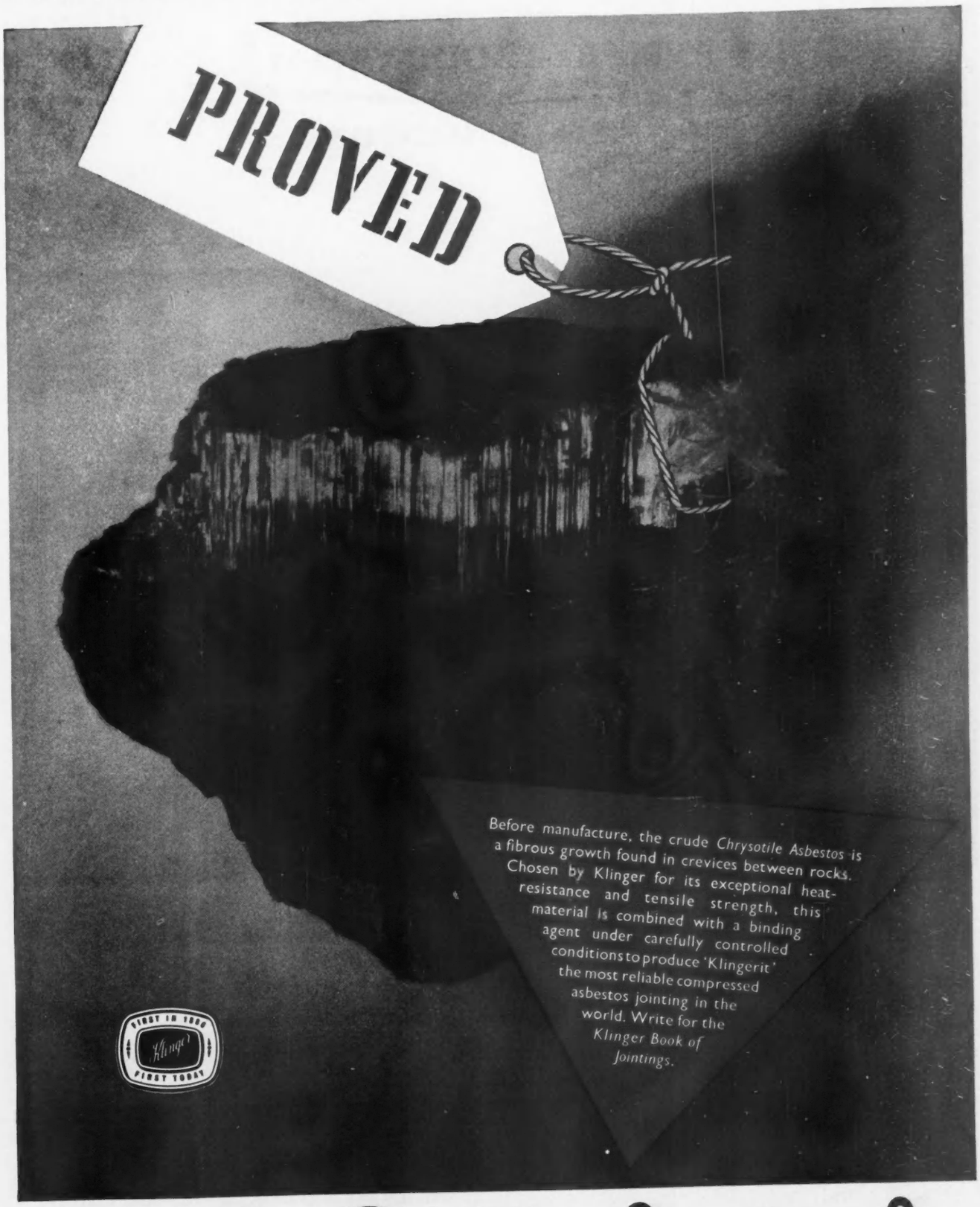
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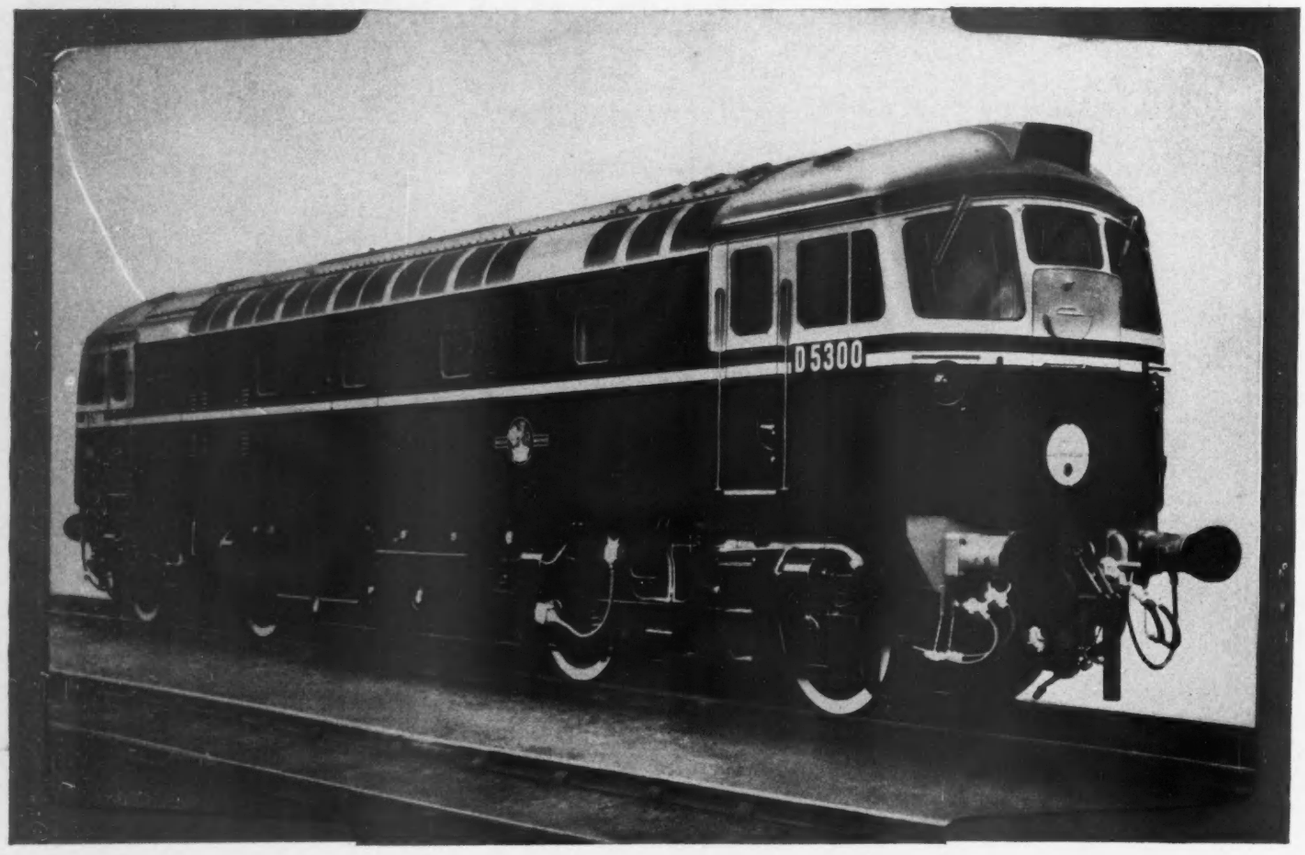

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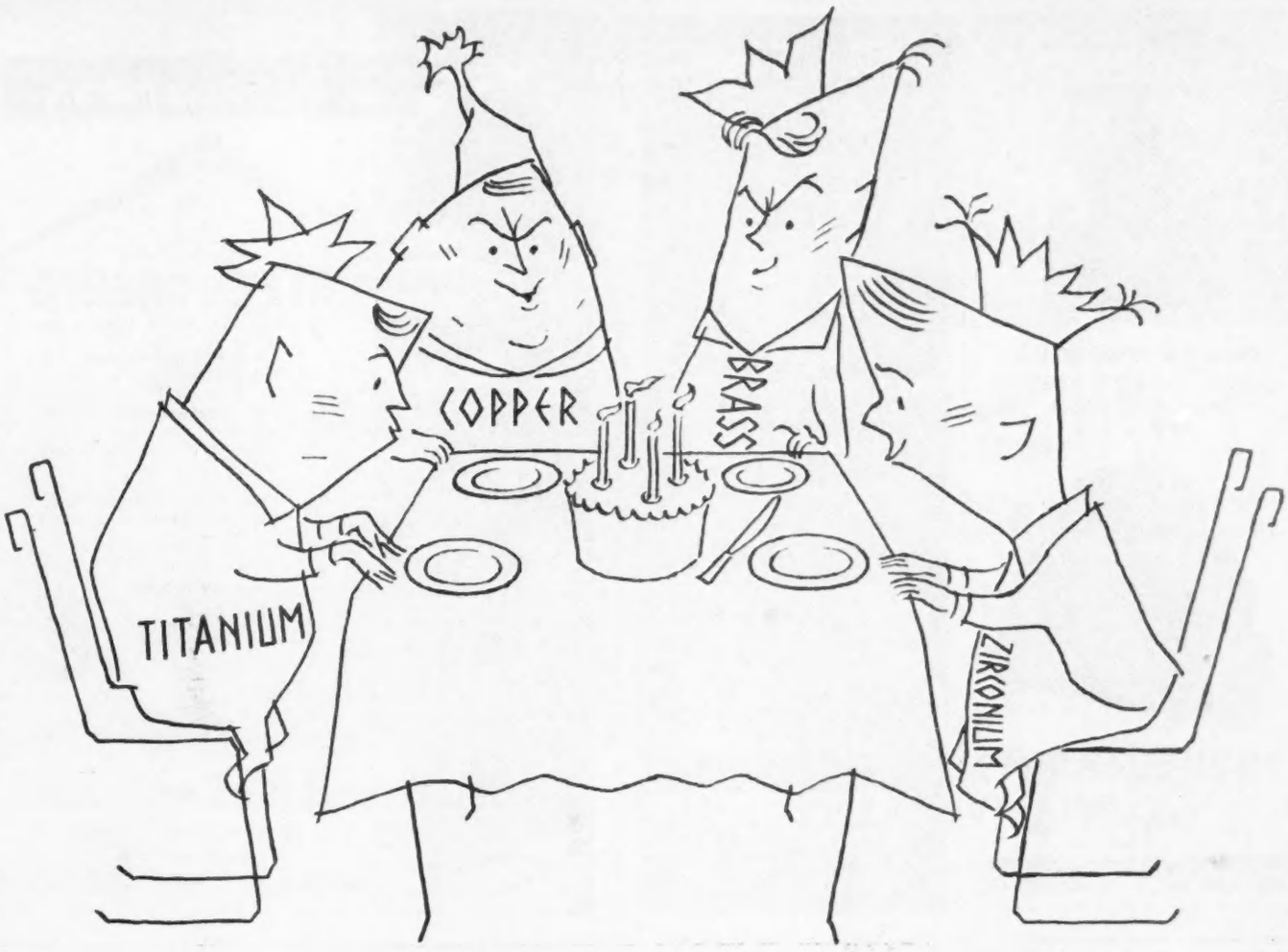

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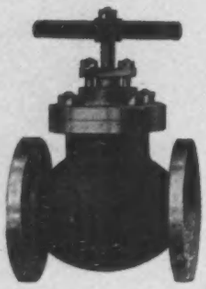

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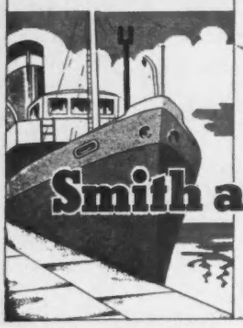

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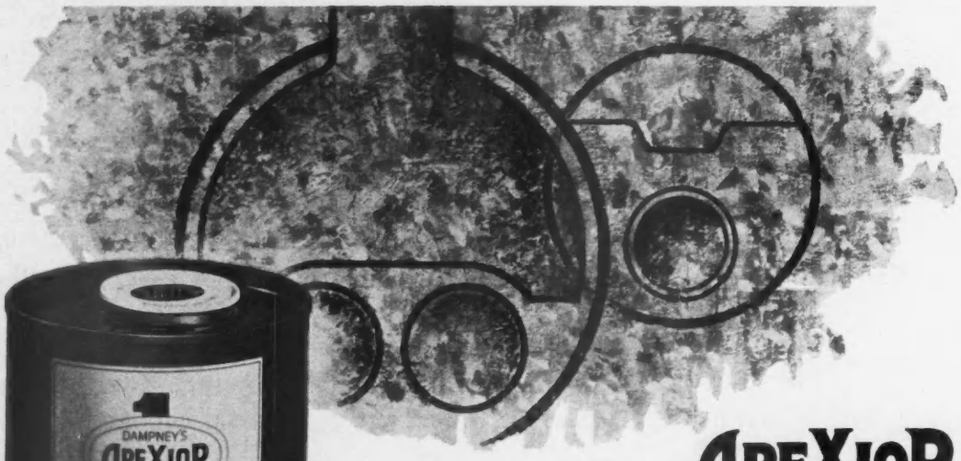

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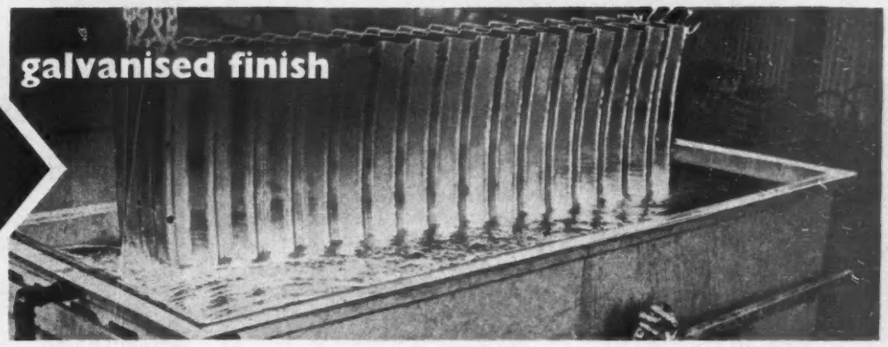

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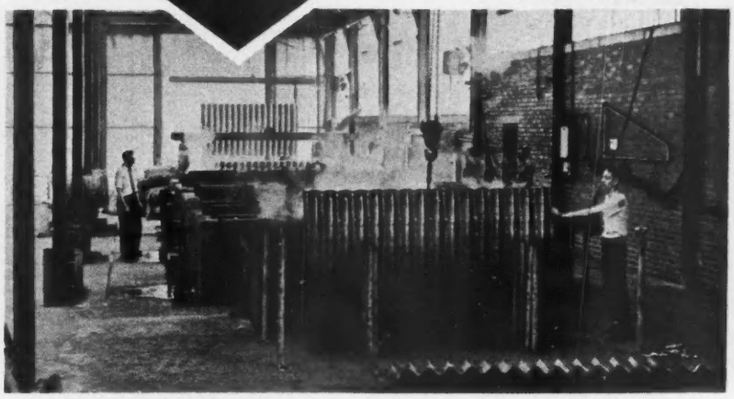

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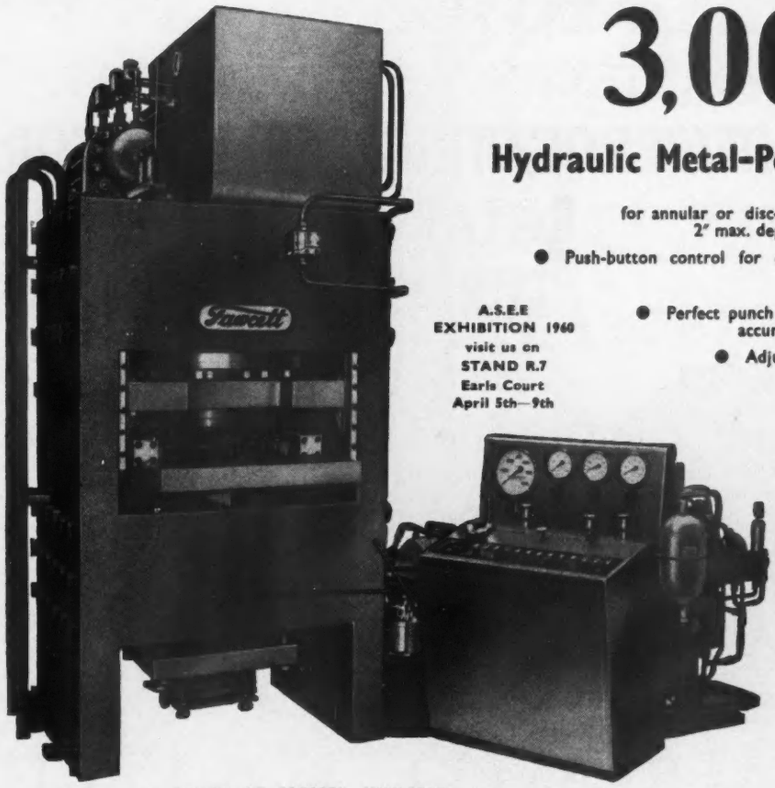

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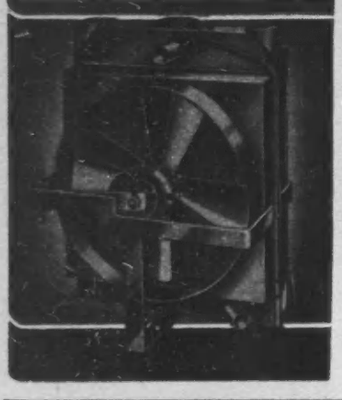

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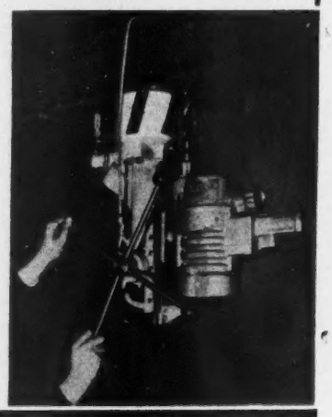

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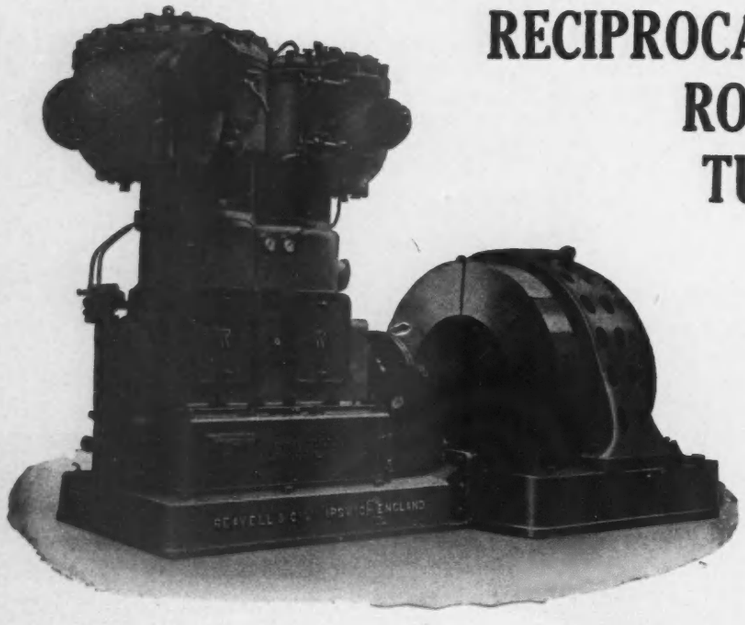

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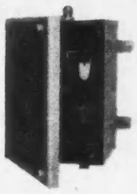

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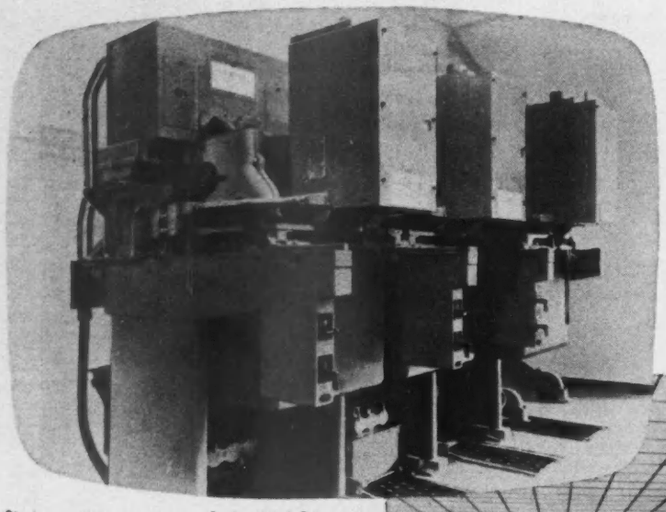

generator switchgear at Calder Hall

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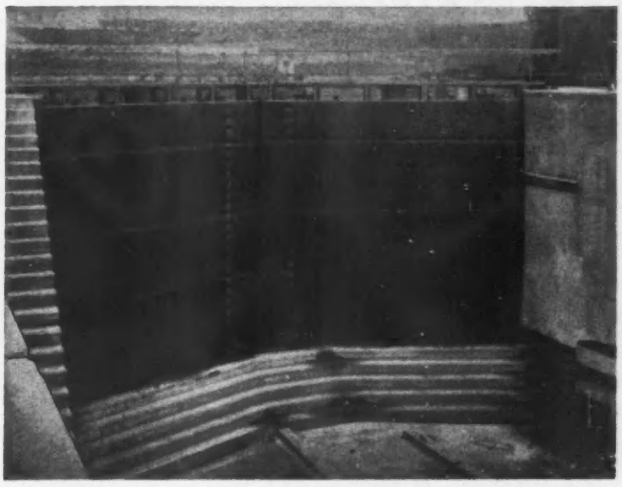

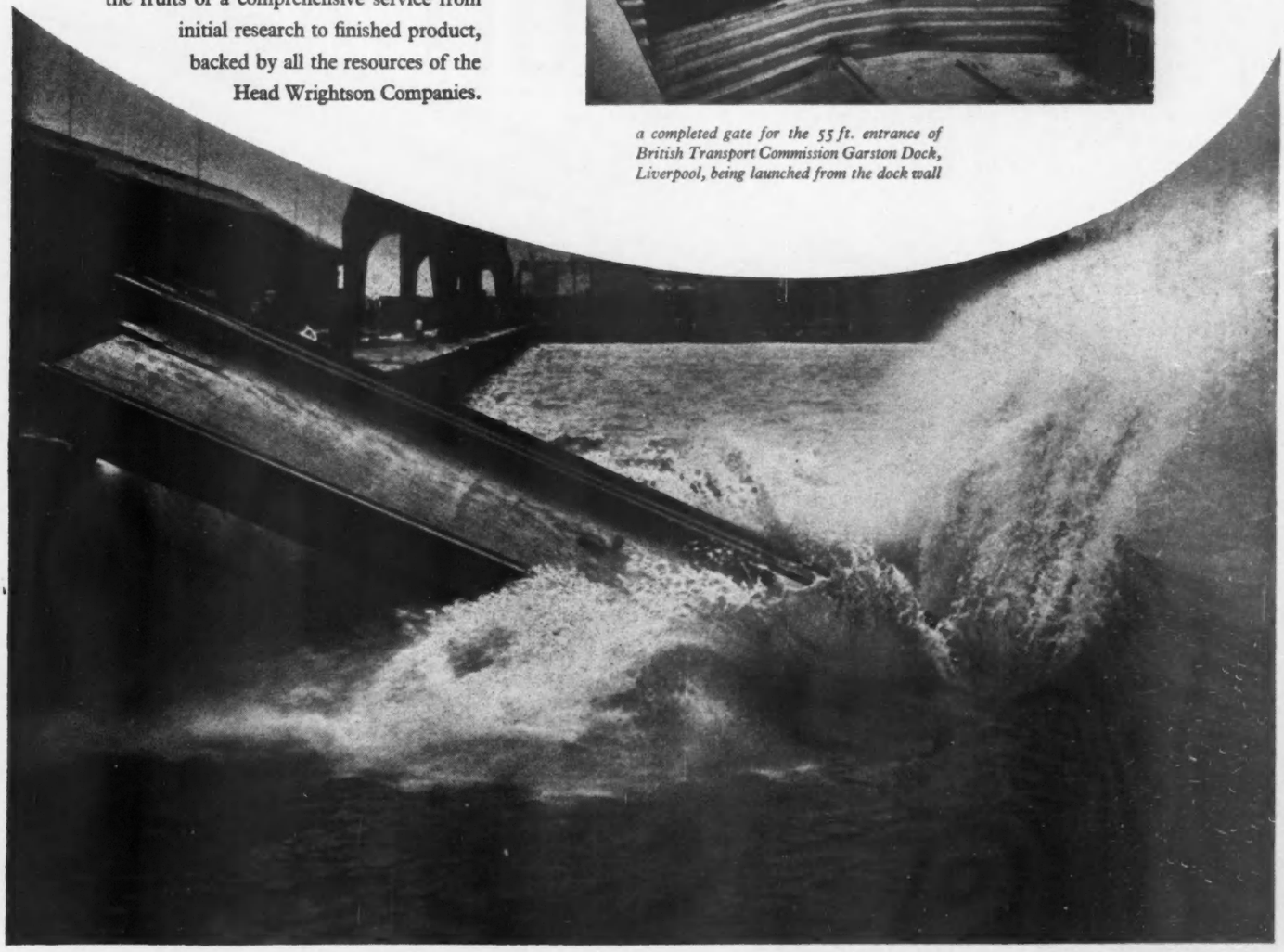

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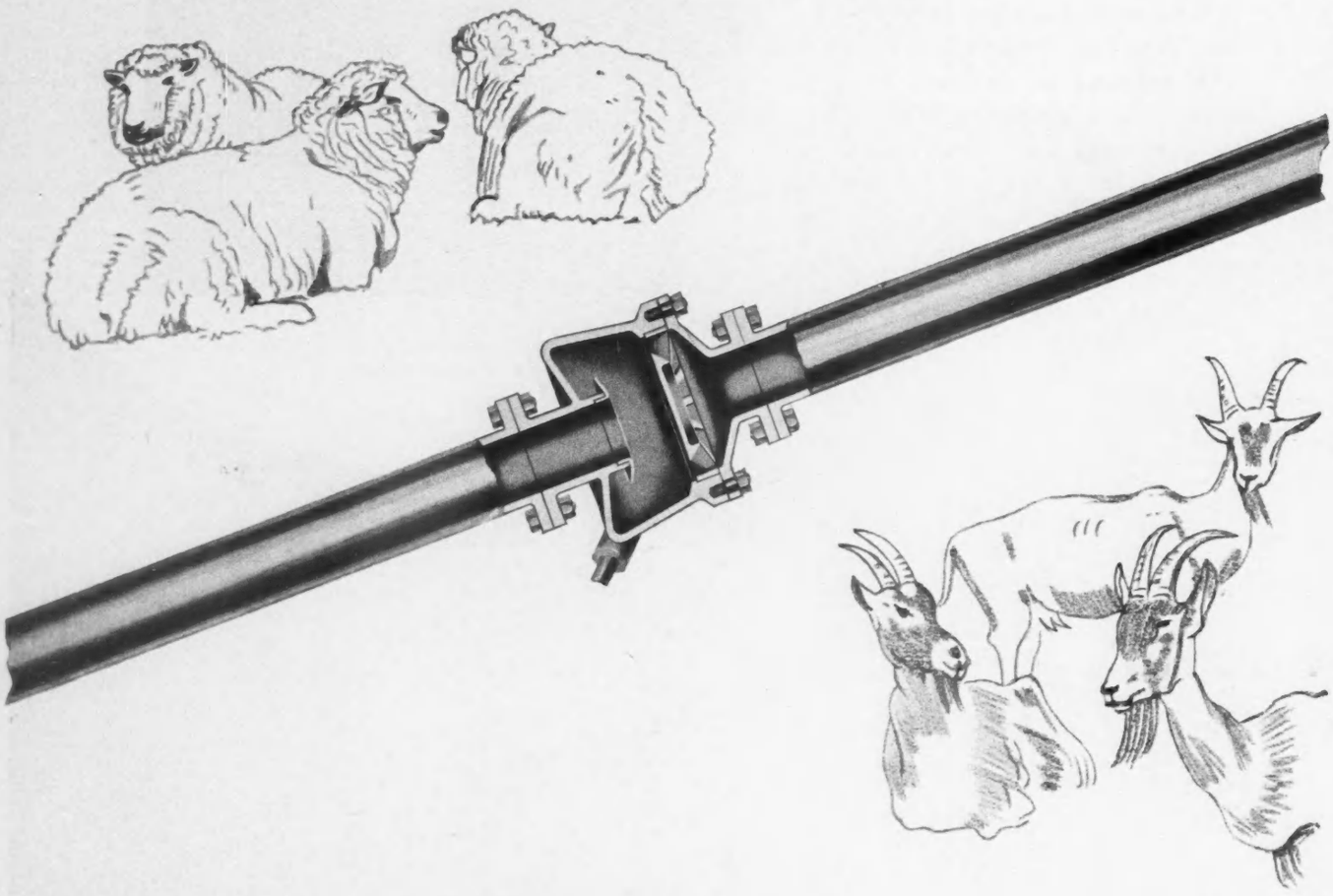

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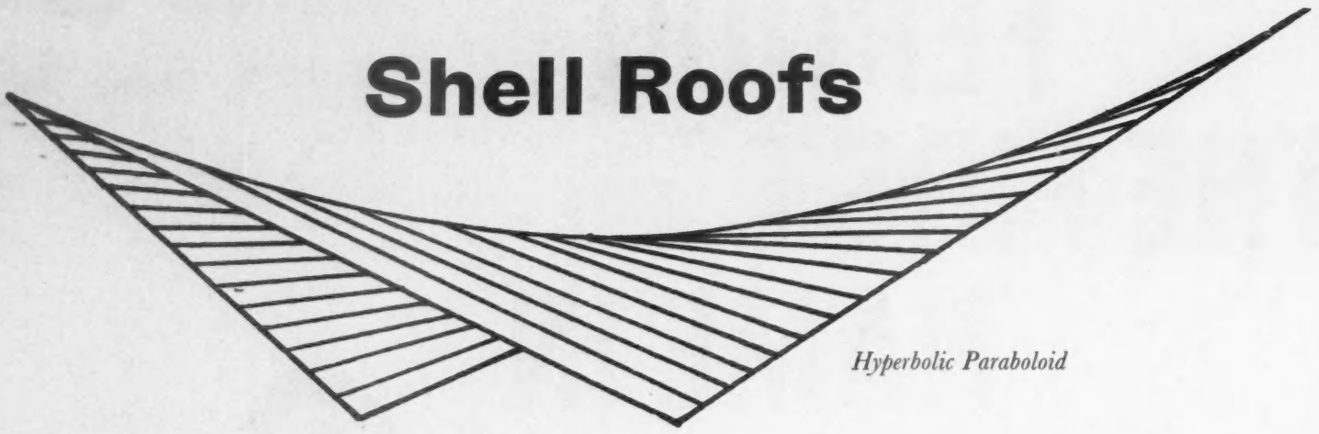

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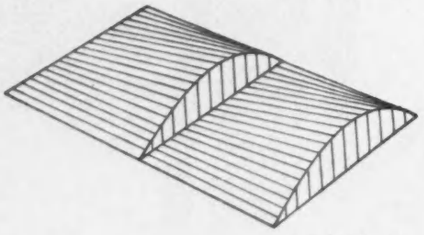

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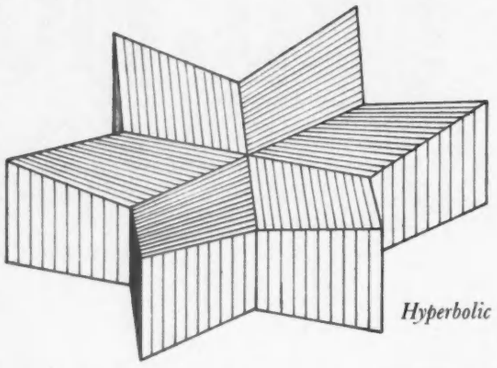

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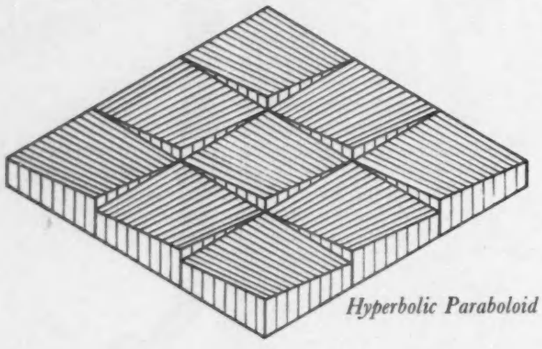

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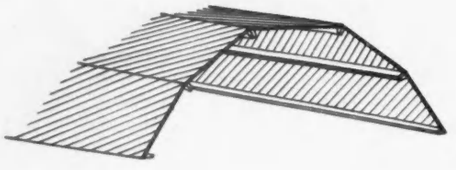

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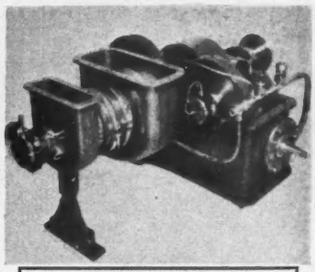

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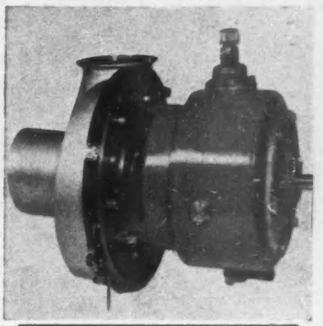

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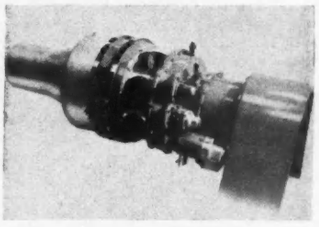
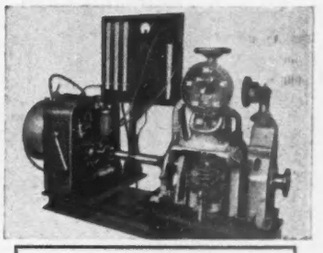


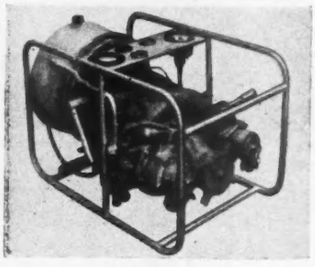
500 H.P. "Basilisk" Gas Turbine (Shaft Power and Air Bleed versions)



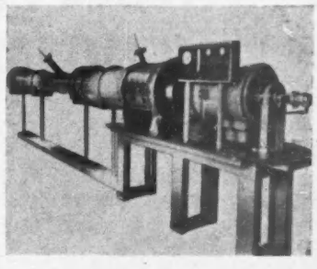
Instructional and Test Set

AXIAL AND RADIAL FLOW AIR COMPRESSORS

500 G.P.M. Lightweight Pumping Set



Axial Flow Compressor for Instructional Use



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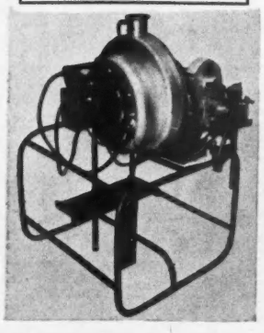
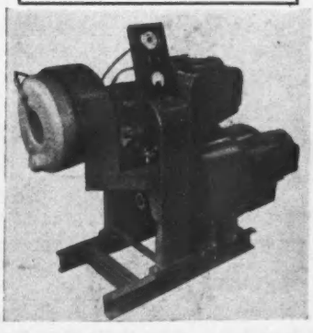


Generating Sets up to 400 kW.



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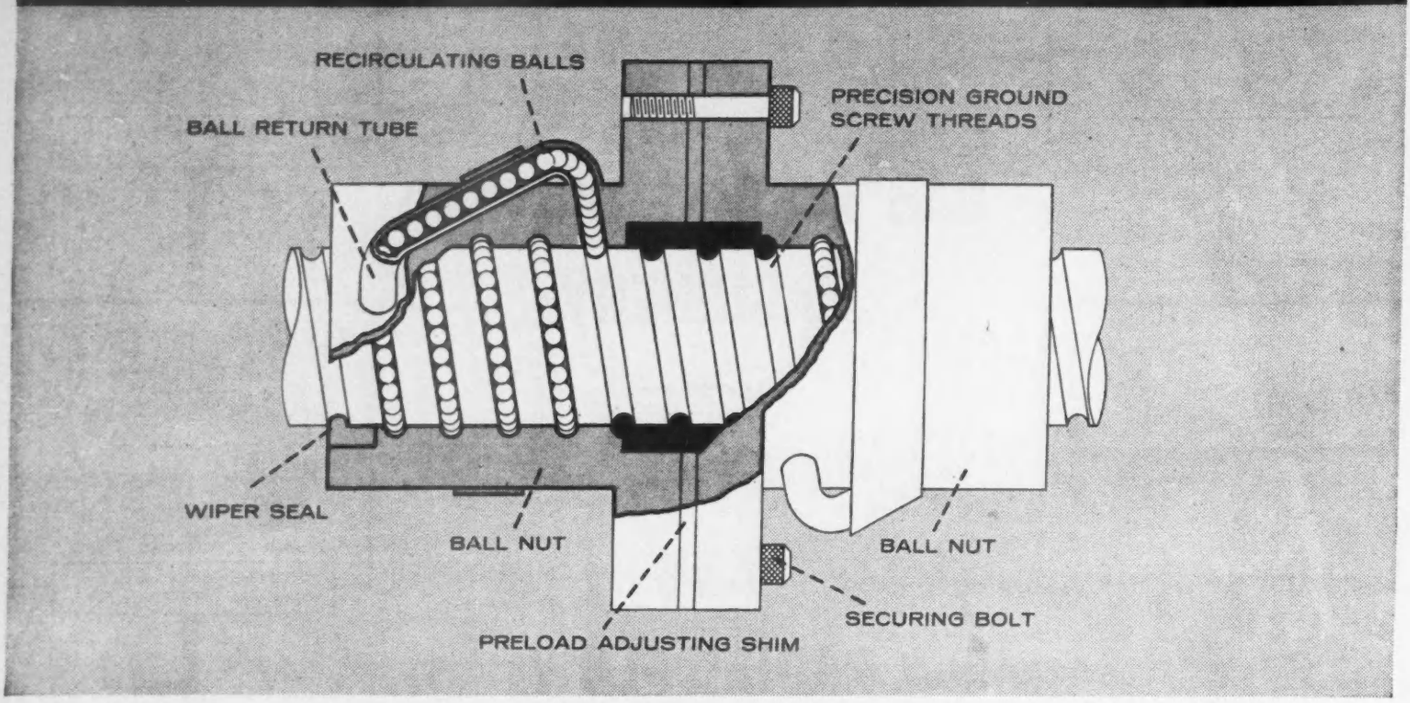
Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...



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Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

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* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

J. B. STARKY, SALES MANAGER (BEAVER PRODUCTS DIVISION), BRISTOL SIDDELEY ENGINES LIMITED, PO BOX 17, COVENTRY, ENGLAND.

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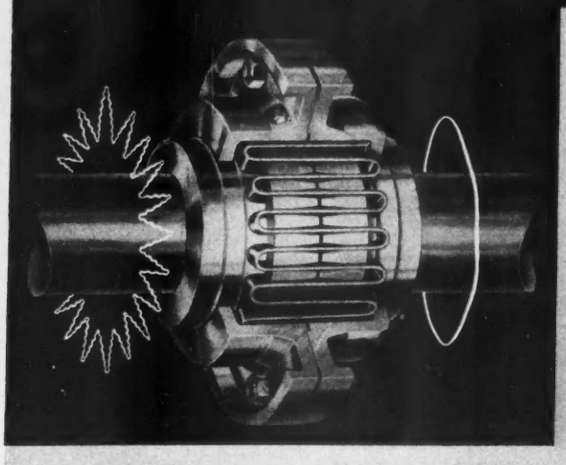

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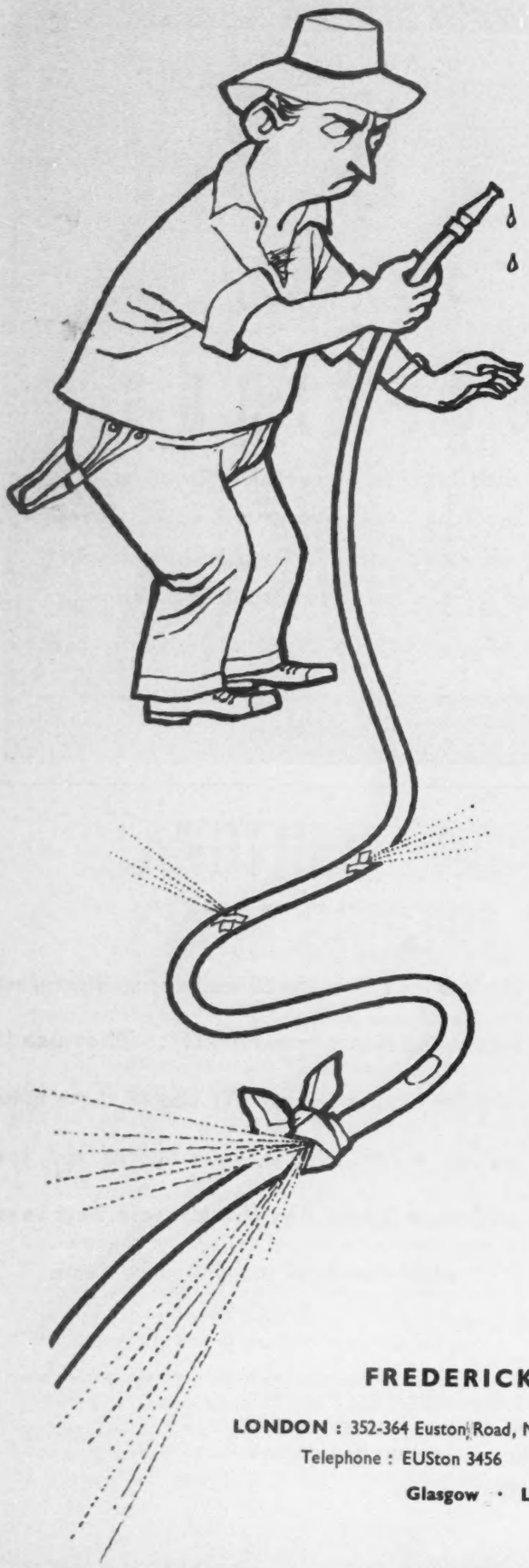

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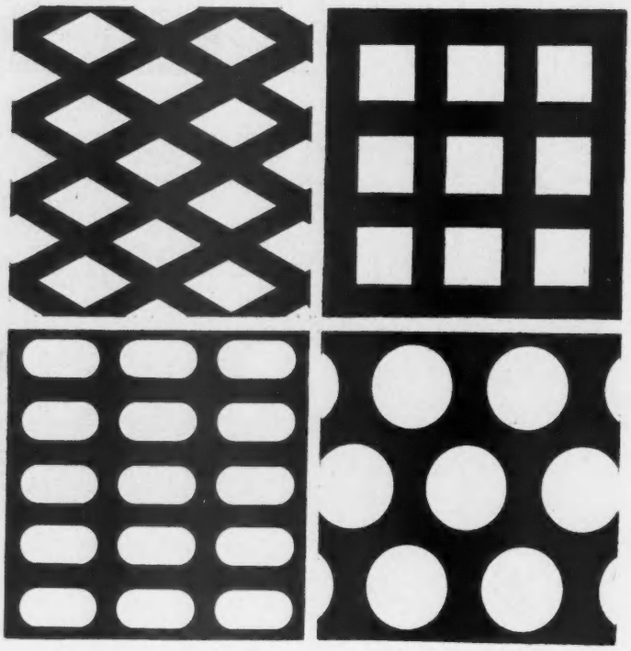

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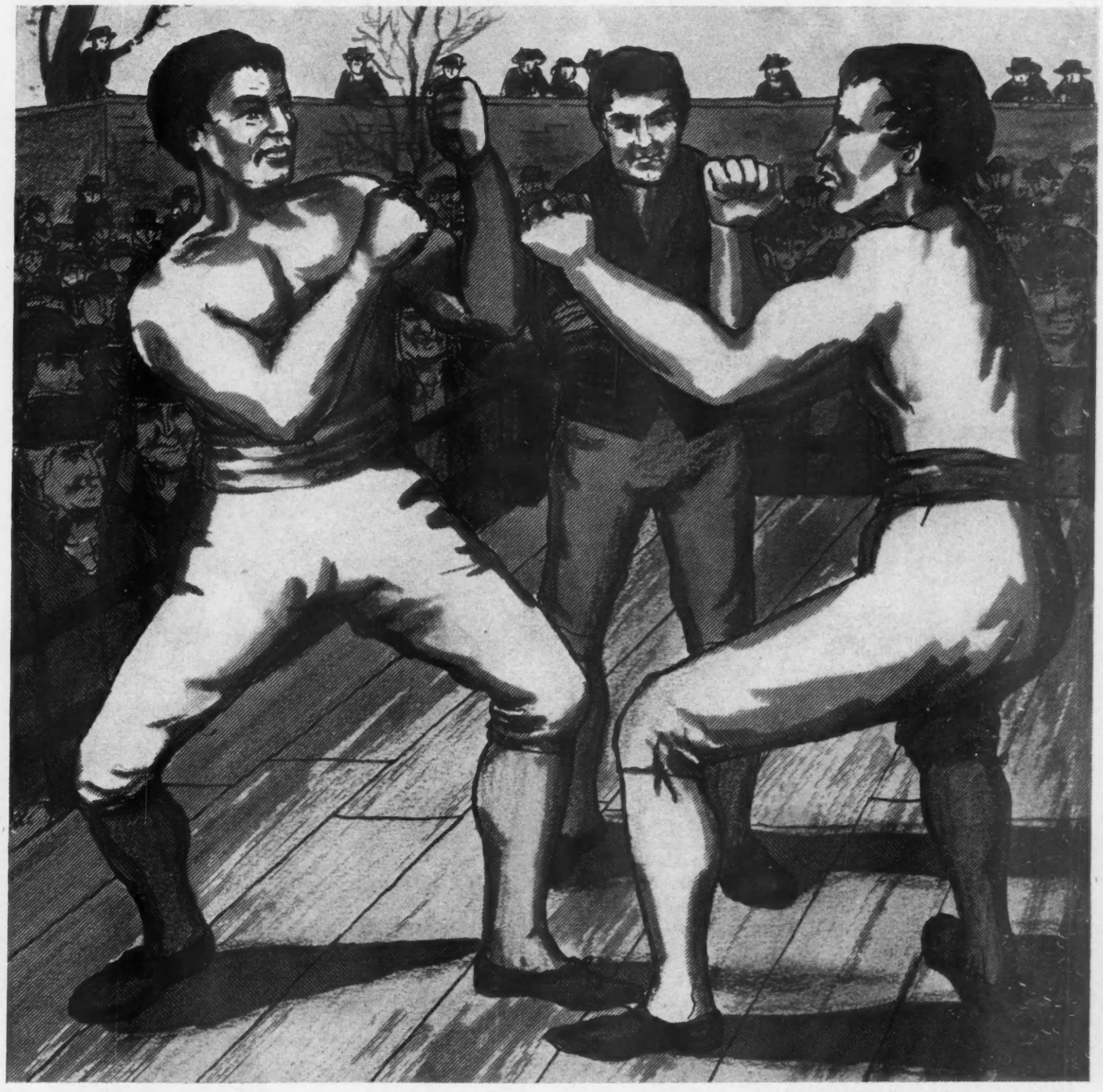

The story of the manly art goes back through the mists of time, and many a Village Green echoed the crash of bone on flesh while brawny bruisers and fine young bucks pounded their prowess in the Englishman's National Sport. Because of dreadful injuries, bare fist contests were eventually stopped by the law, and gloves or 'mufflers' were introduced, thus protecting the fighters and often preserving their very lives.

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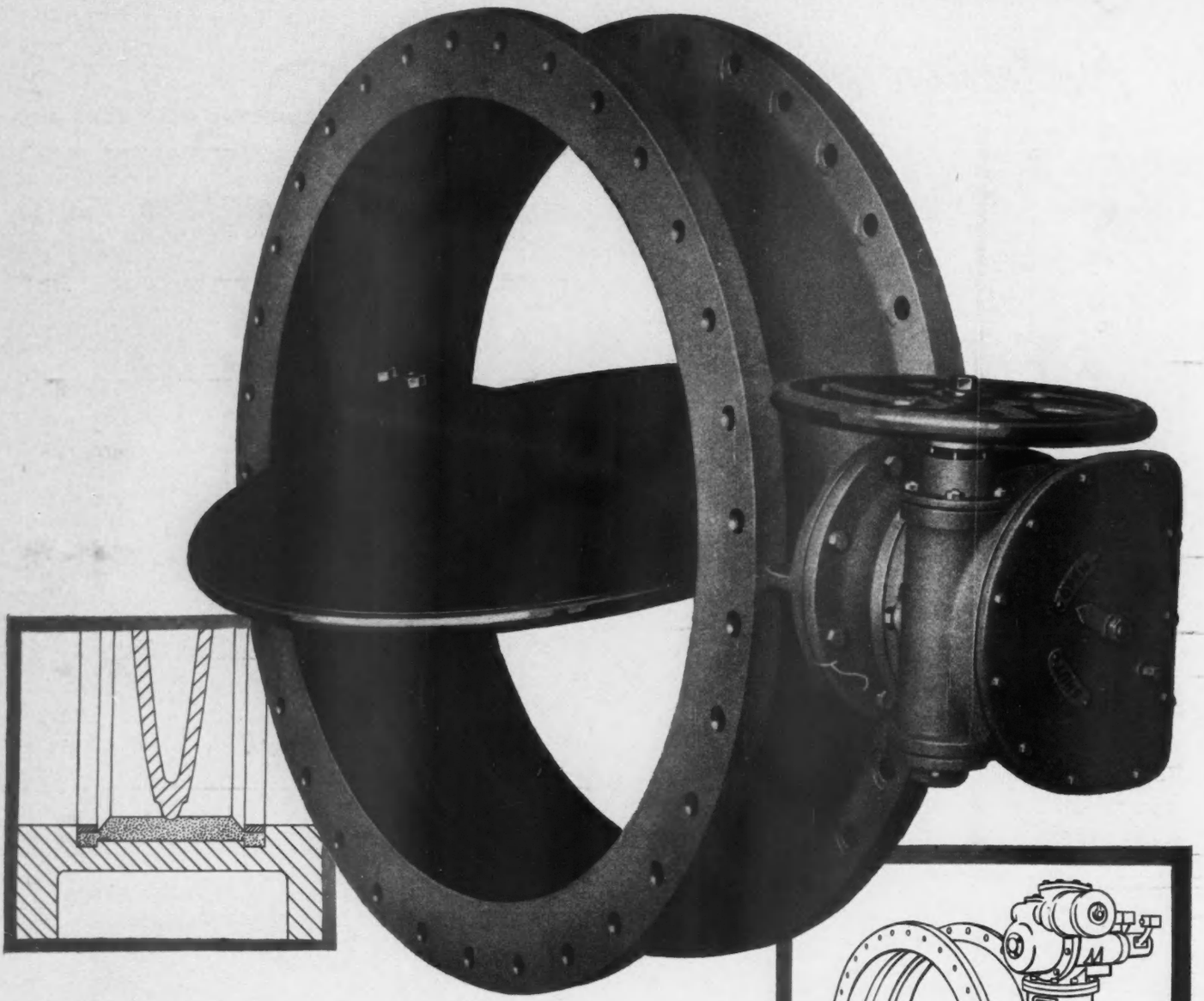

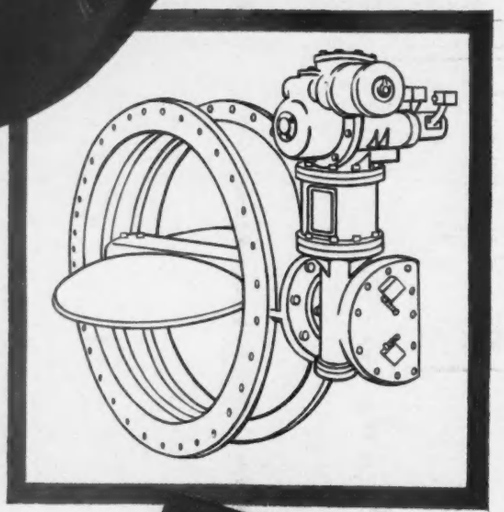

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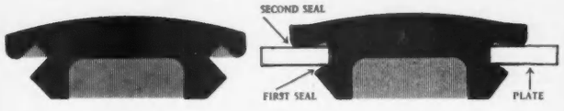
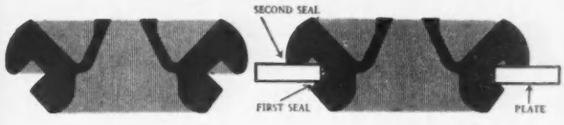


FREE **FITTED**

Note how when sprung into position the grommet provides a perfect double seal by its own permanent pressures. The angled groove also creates a tight pressure hold on the metal plate.

THE NEW DESIGNED GROMMET



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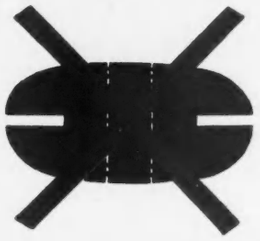
In the cable grommet variety the same double pressure seal is created, allied to tight seal on various diameters of cable. This new grommet gives sound sealing at *all* vital points.



In the conventional grommet, only one thickness of plate and only one size of cable can be accommodated. No effective seal is afforded by the parallel groove.

A useful feature of this cable grommet is that by reason of the designed taper of the cable entry and the flexibility of the web, a considerable angle of cable entry and a variety of cable size are possible. This avoids necessity for special grommets with angled bores.

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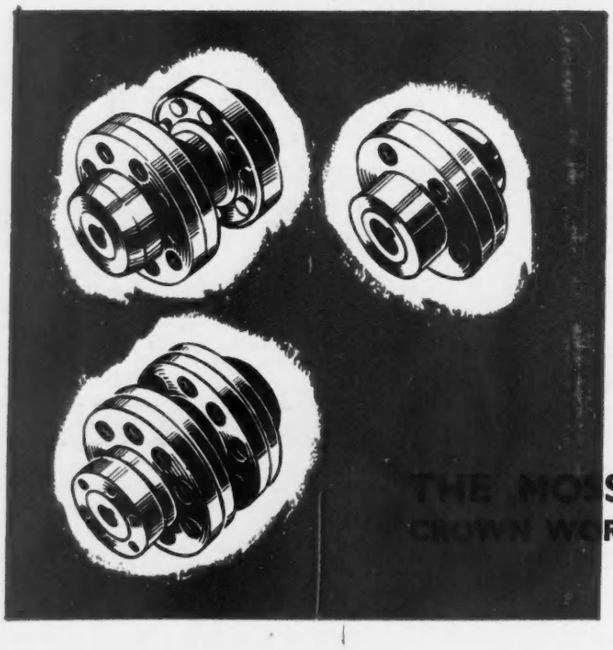

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